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STUDENTS OF MEDICINE

BY

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SIXTH EDITION, THOROUGHLY REVISED

BY

FRED J. BROCKWAY, M.D.

Assistant Demonstrator of Anatomy, Columbia University, New York

PHILADELPHIA AND LONDON
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1902

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PREFACE TO SIXTH EDITION.

In revising "The Essentials of Anatomy" the general outline and arrangement of the former editions have been preserved, some new matter has been added, a few small cuts have been discarded or replaced by larger ones, descriptions and statements have been corrected to accord with recent works, and many small words have been inserted, adding to the clearness of description. The revision has been made with a desire to promote the aims of the book as set forth by the author in his preface to the first edition.

Fred J. Brockway.

PREFACE TO FIRST EDITION.

The author has endeavored in this little book to embody only those facts which have appeared to him to be really the "essentials of anatomy;" not that he considers it likely that the student will master every minute detail therein contained, but he believes that the knowledge gained by a study of this work will enable the future practitioner, during the remainder of his professional life, to recall such general impressions as will render intelligible current medical literature, or even the more elaborate monographs, and will at once suggest *where* to

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consult his anatomical text-books for such terms or facts as may have become indistinct through lapse of time.

While this book cannot replace the larger anatomical works, sufficient descriptive matter has been introduced to enable the student to refresh his memory of the more numerous facts learnt in the lecture and dissecting room, or from his "Gray" or other text-book, differing in this respect from most of the works of its class, which are little more than a list of names, without any distinctive facts connected with them to aid the student in the difficult task of acquiring a knowledge of a branch of medical study almost solely dependent upon the unassisted powers of the memory.

Conciseness, rather than elegance of diction, has been the aim, so that all words such as the articles "a," "an," "the," have been omitted, except where absolutely necessary.

Recognizing that a work of this kind should, as far as possible, conform to that text-book most commonly used, the last edition of Gray's *Anatomy* has been chosen as the chief authority, although free use has been made of the works of Quain, Leidy, Bock, Allen, Morris *On the Joints*, Starr *On Diseases of Children* (dentition), Tomes *Dental Anatomy*, Potter, Frey, Holden, Politzer, H. Thompson, Astley Cooper *On the Breast*, and original work of one of the author's former students.

The author would here acknowledge his obligations and return his thanks to Prof. Joseph Leidy, of the University of Pennsylvania, for the kind permission to reproduce numerous cuts from the first edition of his *Anatomy*, and to Dr. F. M. Varrell for much valuable assistance in the correction of proof.

CHARLES B. NANCREDE.

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ESSENTIALS OF HUMAN ANATOMY.

Give the derivation and meaning of the term anatomy.

From two Greek words, ἀνά, apart, and τέμνειν, to cut, literally meaning dissection; but it is used to indicate the study of the physical structure of organized bodies.

How is human anatomy divided?

Into two great divisions, viz.: 1. General or descriptive anatomy, which deals with the separate parts of the human body. Histology is a part of general anatomy in which the structural elements are studied, usually with the aid of a microscope. 2. Surgical or regional anatomy describes the relations which individual parts—muscles, nerves, arteries, etc.—bear to each other.

What is osteology?

A subdivision of general anatomy, describing the number, form, structure, and uses of the bones.

What is the chemical composition of osseous tissue (bone)?

About one-third (33.3) is organic or animal matter, resolvable into gelatin after prolonged boiling, with traces of chondrigen (the proximate principle of cartilage), and two-thirds inorganic (66.7), consisting of calcium phosphate (tribasic) 51.04, calcium carbonate 11.30, calcium fluorid 2, magnesium phosphate 1.16, and sodium chlorid with traces of sodium dioxid 1.20. Either the organic or the inorganic matter may be removed without affecting the form of the bone; the former, by exposure to heat with free access of air, after which slight force will reduce the bone to powder; the latter, by steeping in dilute hydrochloric acid, which will render a bone as pliable as a strip of rubber. In rickets only about 20 per cent. of lime-salts are deposited and 80 per cent. of animal matter.

Does an increase of the mineral constituents take place in old age?

No, although this is a common statement in text-books; for while equal *bulks* of young and old bones do show marked differences in the proportion of earthy and animal constituents, equal *weights* do not, so that the elasticity in youth and the brittleness in age depend upon the greater sponginess of texture in young bones.

Is bone a homogeneous substance?

No; for while the exterior is composed of a *compact* (hard, ivory) layer, the inner portions are formed of *spongy* or *cancellous* tissue; the interior of long bones is hollow, forming the medullary (marrow) canal. The compact tissue occurs upon the exterior or in the shaft of long bones where "cross-strain" is greatest; whereas cancellous tissue enables the articular ends of the bones to be large for security, yet light, this tissue being capable of bearing enormous pressure, but incapable of bearing much "cross-strain." Probably all solid bone is a definite compound.

Describe the microscopic structure of bone.

In transverse section, with a low power, a number of holes will be observed, averaging $\frac{1}{500}$ inch in diameter, surrounded by a series of tolerably concentric circles, consisting of an interrupted series of dark spots. With high powers the holes, called *Haversian canals* for the passage of vessels, are seen to be surrounded by a series of concentric rings, termed lamellæ, while the dark spots reveal themselves as cavities in the bone, called *lacunæ*, intercommunicating with each other and the central Haversian canal by means of delicate radiating lines, called *canaliculi:* this aggregation of structures is called an *Haversian system.* The lacunæ contain bone-corpuscles, processes of which extend into the *canaliculi.* As each Haversian system communicates by its canaliculi with those of its neighbor and exterior of the bone, all portions of its most compact tissue and the medullary canal freely intercommunicate and receive nutrient material. As these systems are circular, they would leave interspaces where not in contact; but these gaps are filled up by layers of bone with *lamellæ* and *canaliculi*, which portions are called *interstitial lamellæ.* In addition to the *concen-*

tric lamellæ around the Haversian canals, other lamellæ are found arranged concentrically to the circumference of the bone, called *circumferential* or *fundamental lamellæ.* All lamellæ are thin plates of bone; they are held together by the *perforating fibers of Sharpey.*

What are the periosteum and the endosteum?

The periosteum is a membrane serving as a scaffolding to enable the blood-vessels to reach all portions of the exterior of the bone except its articular ends and the points of attachment of strong tendons. It is composed of two portions: the *outer* or *fibrous layer* is dense and protective; the *inner layer* is vascular and contains many *osteoblasts*, or bone-forming cells, upon which the growth in thickness of the bone depends.

The term endosteum is applied to the delicate connective-tissue lining of the medullary and cancellous cavities which contains numerous bone-forming cells.

Describe the medulla or marrow.

There are two varieties, *yellow* and *red:* yellow marrow occurs in adult long bones, and is 96 per cent. fat; red marrow contains 72 per cent. of water and a trace of fat. It is found in all fetal and infantile bones; in the adult it is in the short and flat bones, ends of long bones, vertebræ, cranial bones, sternum, and ribs. Marrow possesses five kinds of cells: fat-cells; marrow-cells proper, resembling leukocytes; nucleated red cells; cells containing red corpuscles; and giant-cells.

Do bones receive blood only from vessels in the periosteum?

No; for the medullary tissue of all long bones receives a good-sized artery (the medullary artery), which obliquely penetrates the compact tissue, after which it divides into two main branches, one ascending, the other descending, in the medullary canal; the veins chiefly emerge through numerous openings near the articular ends of the bones.

Describe the process of ossification.

There are two methods, viz.: (1) *in membrane* and *subperiosteally;* (2) *in cartilage.* The bones of the vertex of the skull and those of the face, with few exceptions, are formed in membrane; the base of the skull and the other bones of the body and limbs are formed in cartilage. (1) In the former the bone-forming cells (*osteoblasts*) arrange themselves along the thick bundles of fibrous tissue which radiate from the center of the future bone; by the deposition of lime-salts in these osteoblasts the deposit of bone shoots out in needle-like rays toward the circumference. (2) A deposit of bone begins at one spot of the cartilage, the *primary center*. The shaft is formed from this. Just before ossification commences the cartilage-cells enlarge and arrange themselves in rows. Lime-salts are deposited in the matrix between the rows, forming columns which enclose oblong spaces containing cartilage-cells, called the *primary areolæ*. Now ossification proper commences by the ingrowth from the periosteum of buds of young connective tissue covered with bone-forming cells, which, after causing absorption of the cartilage, become converted into bone.

Of how many bones is the adult human skeleton composed?

Two hundred, including the os hyoides, but excluding the teeth, Wormian bones, all sesamoid bones except the patellæ, and the ossicles of the middle ear.

Into what classes are bones divided?

Long bones, as femur, tibia, etc., about 90 in number; *flat*, as those of the vault of the skull, scapula, ribs, patella, about 40; *irregular*, as the vertebræ, usually symmetrical, about 40; and *short*, such as the carpal and tarsal bones, numbering 30.

What are Wormian bones?

Irregular fragments, developed from supplementary centers, situated at the junction of two or more cranial sutures, where, during infancy, a membranous interval existed, viz., a *fontanelle*. From their triangular form they are often called *ossa triquetra*.

What are sesamoid bones?

Those developed in the substance of tendons, whereby the muscles obtain additional *leverage—i. e. power;* the patella and pisiform are classed with these bones.

Of what parts do long bones consist, and what are their uses?

Of a shaft (body, diaphysis), two articular extremities, and various processes; they are developed in cartilage, from one principal and one or more additional (epiphyseal) centers of ossification; they serve as supports and levers for power and progression.

Where are short and flat bones employed, and why?

In the carpus and tarsus, where strength with limited motion is required. The flat bones consist of two layers of compact tissue with interposed cancellous tissue, called *diploë;* they serve for protection and muscular attachment.

What facts are noted concerning the medullary arteries?

1. Medullary arteries run *from* the knee and *toward* the elbow. 2. The secondary center *from* which the artery runs is the *first* to appear. 3. The epiphysis *first* to appear is *last* to unite.

How are bony prominences and cavities named?

Each variety offers an *articular* and a *non-articular* division.

Give the names and characteristics of the chief articular processes.

Head, a convex smooth projection, with a constriction or neck beneath; found in freely moving joints.

Condyles, double projecting processes, may have a constriction or neck—*i. e.* neck of condyle of jaw.

Mention some of the non-articular processes, with their meanings.

Trochanters, short projecting levers near articulations to facilitate *rotation* of the bone on its long axis.

Tuberosities, roughened, broad prominences.

Tubercles, similar to the above, but small with reference to the size of the bone.

Spines and *spinous processes*, more or less pointed projections.

Apophysis, strictly speaking, any bony process which develops from the primary center of ossification, commonly used, however, for any process, even if an epiphysis, *after* it has coössified with the mass of the bone. Certain descriptive terms are used: *azygos*, without a fellow; *coracoid*, like a crow's beak; *mastoid*, like a nipple; *rostrum*, a beak; *styloid*, pen-like; *squamous*, like a scale; *vaginal*, ensheathing; *clinoid*, like a bed.

Name some of the articular cavities of bone.

Cotyloid, when they resemble a deep cup; *glenoid*, whe they have a shallow cup-form; *trochlear*, pulley-like; *facet*, when smooth, like one of the surfaces of a cut gem; *sigmoid*, when *c*-shaped, resembling the old Greek letter for ς.

What are the principal non-articular cavities called?

Fossæ, shallow depressions; *sinuses*, deep cavities, communicating with the exterior by small openings; *grooves*, long, narrow depressions; *fissures*, cracks; *notches*, deficiencies of edges of bones; *foramina*, holes through bones for transmission of nerves, etc.

What is a diaphysis?

The main portion of a bone (shaft in a long bone, body in an irregular one) between the *epiphyses*.

What is an epiphysis?

A supplementary center, usually to provide for growth in *length*, developed in cartilage, which remains separated by a layer of *epiphyseal cartilage* until the growth of the bone is completed, when it coössifies with the *diaphysis*, and all further growth ceases. Epiphyseal centers appear after birth: they coössify in the inverse order of their appearance, except that of the lower end of the fibula. This process of coössification commences about puberty, and the last to unite are those of the upper end of the tibia and the vertebral bodies—as late as twenty-five years.

BONES OF THE HEAD.

Name the bones composing the skull.

They are twenty-two in number: eight of which (*cranial*) compose the brain-case, viz., one frontal, two parietal, two temporal, one sphenoid, one occipital, and one ethmoid; fourteen are *facial*, two superior maxillary, two malar, two nasal, two lacrimal, two palatal, two inferior turbinated, one vomer, and one inferior maxillary, or mandible; the ethmoid of the cranium also enters largely into the formation of the nasal cavities.

The Frontal Bone.

Of what parts does this bone consist?

Of a vertical and a horizontal portion, meeting at an angle of 60°.

Describe the points on the outer surface of the vertical portion (Fig. 1).

On each side of the median line are two *frontal eminences*, between which are the remains of, or the obliterated (*metopic*) *frontal suture*, leaving a slight linear *depression*, which, above the root of the nose, terminates in a rounded, projecting *nasal eminence* (glabella). Extending from this on each side are two curved, rounded *superciliary ridges*, situated behind which, between the two tables of the skull, lie the *frontal sinuses* (Fig. 2). The junction of the vertical and horizontal portions forms on each side a curved margin, the *supra-orbital arch*, notched or perforated toward its inner part by the *supra-orbital notch*, or *foramen*, transmitting the artery and nerve of the same name. Each orbital margin terminates by two stout processes, called *internal angular* and *external angular processes*. Between the two inner projects the *nasal process*, in the rough, uneven space, called the *nasal notch;* the under surface of the nasal process presents a median ridge, *nasal spine*, between two

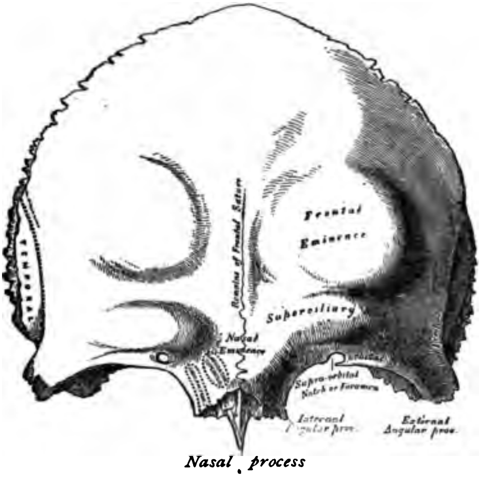

FIG. 1.—Frontal bone, outer surface (Gray).

grooves. The margin of the external angular process extends upward as the *inferior temporal ridge* (Fig. 1).

Describe the points on the cerebral surface.

In the median line a *frontal sulcus* (Fig. 2) (for the longitudinal sinus) exists, whose edges coalesce below to form the *frontal crest*, which terminates as a notch, or perhaps complete *foramen cæcum* (blind), which when pervious transmits a small vein.

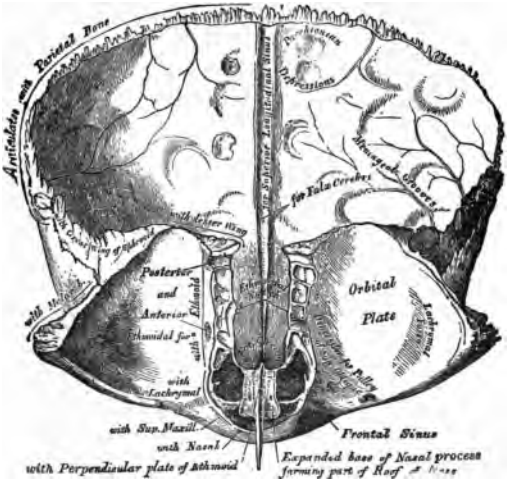
Articulates with Parietal Bone
Pacchionian Depressions
for Superior Longitudinal Sinus
Meningeal Grooves
for Falx Cerebri
with Lesser Wing
with Greater wing of Sphenoid
with Malar
Posterior and Anterior Ethmoidal for.
with Ethmoid
Ethmoidal Notch
Orbital Plate
Lachrymal Fossa
Depression for Pulley
with Lachrymal
with Sup. Maxill.
with Nasal
with Perpendicular plate of Ethmoid
Frontal Sinus
Expanded base of Nasal process forming part of Roof of Nose

FIG. 2.—Frontal bone, inner surface (Gray).

Describe the horizontal portion.

This consists of two *orbital plates* of a triangular outline, separated by a quadrilateral *ethmoidal notch* (for articulation with the ethmoid). A shallow *lacrimal fossa* (for the gland) exists at the outer part of the orbit, also a *trochlear fossa* or sometimes a small *tubercle* at the anterior inner part for the pulley of the superior oblique muscle. Several half cells are seen along the margins of the ethmoidal notch, which complete the ethmoidal cells when the ethmoid is in position, as well as two *grooves*, which are likewise converted into the *anterior* and *posterior ethmoidal canals*, the former for the nasal nerve and anterior ethmoidal vessels, the latter for the posterior ethmoidal vessels. On each side of the nasal process open the *frontal sinuses* (absent in infants), a part of the nasal cavities, into which each opens by the *infundibulum.* The cerebral surfaces of both vertical and horizontal portions present numerous depressions for the convolutions of the brain, and branching grooves for the anterior meningeal arteries.

What centers of ossification has this bone?

Two develop near the orbital arches, in membrane, at the seventh or eighth fetal week.

With what bones does it articulate?

With two parietal, the sphenoid, the ethmoid, two nasal, two superior maxillary, two lacrimal, and two malar—twelve in all.

What muscles arise from it?

The corrugator supercilii, orbicularis palpebrarum, and temporal on each side.

The Parietal Bones.

Describe a parietal bone?

It is of a quadrilateral form, convex externally, concave internally. It presents four borders, four angles, and two surfaces. Its upper serrated border forms with its fellow the *sagittal suture;* the anterior alternately bevelled margin joins the frontal, forming part of the *coronal suture;* the inferior border presents three parts, bevelled in front for the wing of the sphenoid, next for the squama, then serrated for the mastoid; the posterior serrated border articulates with the occipital (*lambdoid suture*). The antero-superior angle is at the junction of the coronal and sagittal sutures; the antero-inferior angle fits under the wing of the sphenoid and internally presents a groove or canal for the anterior branch of the middle meningeal artery; the postero-superior angle marks the apex of the lambdoid suture; the postero-inferior angle articulates with the mastoid and internally shows a groove for part of the lateral sinus.

The *external surface* shows near its center the *parietal emi-*

nence or *boss.* Curving across the middle of the bone are the *upper* and *lower temporal lines* or ridges, for attachment of the temporal fascia and muscle; and near the posterior superior angle is often a *parietal foramen* transmitting a small vein to the superior longitudinal sinus (sometimes a small branch of the occipital artery).

The *inner surface* is concave, and its deepest part is the *parietal fossa.* It is marked with numerous smooth *digital depressions* for the brain convolutions, with a shallow *half groove* (Fig. 4) along the superior border for the superior longitudinal sinus, and several *Pacchionian depressions.* There are furrows for arteries and often the opening of the parietal foramen.

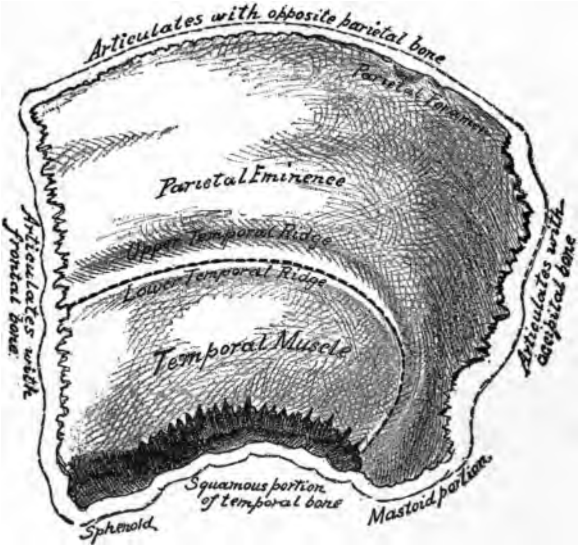
Articulates with opposite parietal bone
Parietal foramen
Parietal Eminence
Upper Temporal Ridge
Lower Temporal Ridge
Temporal Muscle
Articulates with frontal bone
Articulates with occipital bone
Squamous portion of temporal bone
Mastoid portion
Sphenoid

FIG. 3.—Left parietal bone, external surface.

How is it developed?

In membrane, from two centers which coalesce at the eminence, appearing at the fifth to sixth fetal week.

Give muscular attachments and articulations.

Temporal muscle: articulates with five bones, the opposite parietal, occipital, temporal, frontal, and sphenoid.

The Occipital Bone.

Of what parts does this bone consist?

The occipital bone is a curved, trapezoidal plate situated at the posterior part and base of the skull. It is convex posteriorly and concave anteriorly. At birth the bone consists of four pieces. At its lower and anterior part is the foramen magnum. Behind this is a *tabular portion* (squamo-occipital), the upper part of which may be separate, the *interparietal bone* (bone of the Incas); the lower part is *supra-occipital.* On either side of the foramen are *condylar portions* (ex-occipitals), and in front is the *basilar portion* (basi-occipital). The bone may be described by its fetal divisions or as a whole; in the latter case it presents two surfaces, four borders, and four angles. The *external surface* (Fig. 5) presents midway between the sum-

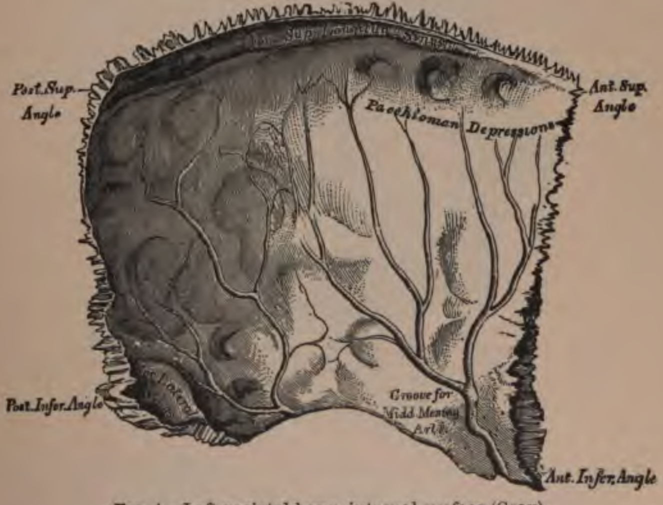

FIG. 4.—Left parietal bone, internal surface (Gray).

mit and foramen magnum the *external occipital protuberance* (inion) for attachment of the ligamentum nuchæ and biventer cervicis muscle. Descending from it to the foramen is the *median external occipital crest.* The ligamentum nuchæ is attached to it also. Passing outward from the protuberance on each side to the lateral angle is the *superior curved line*, or superior nuchal line. Internally and above this line is often the *supreme curved line* for attachment of the middle portion of the occipito-frontalis aponeurosis. Between these two lines the bone is smooth and dense, the *torus transversus* (transverse bulge). From the middle of the external crest a semicircular *inferior curved line* runs outward on each side and bends sharply downward to the jugular process. To the superior curved line is attached internally the trapezius and externally the occipitalis and sterno-mastoid muscles. Below this line internally is a large impression for the complexus; then come the superior oblique and splenius capitis above and externally. To the inferior line and depressions below it are attached the rectus posticus minor internally and the major

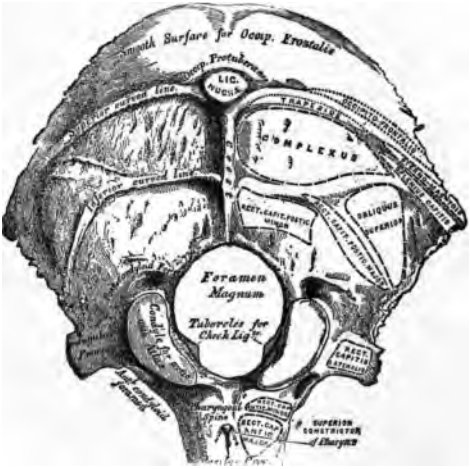

FIG. 5.—Occipital bone, outer surface (Gray).

externally. The *foramen magnum* is an oval aperture, 30 to 35 mm. in its long axis. It transmits the medulla and its membranes, the spinal part of the spinal accessory nerves, vertebral and spinal arteries, and occipito-axial ligaments. It is broader behind than in front, and bevelled internally. The *condyles* are on either side of the foramen for articulation with the atlas. They converge in front, are reniform, with smooth, oblong, articular surfaces looking downward and outward. Internally is a depression for the insertion of a check ligament. Behind the condyle is the *posterior condylar fossa*, often containing the *posterior condylar foramen* for transmission of a vein. External to the condyle is the *jugular process*, presenting a *jugular notch* in front, which forms a part of the jugular fossa. The under surface presents an eminence (paramastoid), the attachments of the rectus capitis lateralis muscle and of a lateral ligament;

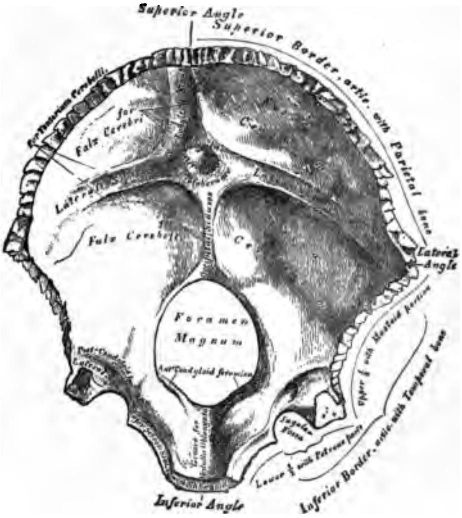

FIG. 6.—Occipital bone, inner surface (Gray).

the outer surface is a rough, cartilaginous facet for articulation with the temporal bone. The *basilar process* projects forward and upward in front of the foramen. It is narrow and thick in front. Below it presents the *pharyngeal spine* for the attachment of the superior constrictor of the pharynx, and impressions for the rectus capitis anticus major and minor muscles.

Describe the cerebral surface of the bone (Fig. 6).

It is deeply concave, divided into *four fossæ* by a *crucial grooved ridge*, crossing at a prominent *internal occipital protuberance;* the two upper fossæ lodge the occipital lobes of the cerebrum, the two lower, the hemispheres of the cerebellum; the two lateral and superior grooves lodge, respectively, between the layers of the tentorium cerebelli and the falx cerebri, the lateral and part of the superior longitudinal sinuses; the inferior groove, or *internal occipital crest*, has attached the *falx cerebelli*, and lodges in two grooves, the *occipital sinuses.* Between the sinuses is the *vermiform fossa.* Perforating the base of the condyle downward and outward is the *canalis hypoglossi*, sometimes double, ending in the *anterior condylar foramen* transmitting the hypoglossal nerve, emissary veins, and a branch of the ascending pharyngeal artery. The upper surfaces of the jugular processes are deeply *grooved* for the lateral sinuses. The upper surface of the basilar process shows the *basilar groove* for the medulla, and laterally a half groove for the inferior petrosal sinus.

Angles.—The *superior angle* is the apex of the tabular portion; the *inferior angle* is the end of the basilar process; the *lateral angles* correspond to the ends of the superior curved lines.

Borders.—The *superior borders* between the upper and lateral angles form the lambdoid suture, occipito-parietal; the upper part of an *inferior border* extends from the lateral angle to the jugular process, masto-occipital; the lower part articulates with the petrous portion of the temporal, petro-occipital suture, which presents posteriorly the *jugular fossa* (foramen lacerum posterius).

Attachment of muscles.

Thirteen pairs, as mentioned above.

With what bones does it articulate?

Two parietal, two temporal, sphenoid, and atlas; six in all.

What centers of ossification has it?

Four in the tabular portion; upper pair in membrane (eighth fetal week), one for the basilar, and one for each condyloid portion in cartilage (seventh or eighth fetal week); in four pieces at birth, in the sixth year it forms one bone.

The Sphenoid Bone.

What are its divisions and where is it situated?

A *body*, two *lesser wings*, two *greater wings*, two *pterygoid plates*, two *spinous processes*, and six *clinoid processes;* it is situated at the base of the cranium, articulating with all the other cranial bones, and five or seven of the face. Named from a Greek word meaning *wedge;* in the process of development this is its function. It also somewhat resembles a bat with extended wings.

Describe the body of the sphenoid.

It is large, cuboidal, hollowed out (in adult) into the *sphenoidal sinuses* (Fig. 8). *Superiorly*, in front, is a sharp projecting *ethmoidal spine* for the ethmoid; behind this, a smooth surface with a longitudinal eminence producing two shallow *olfactory grooves*, bounding which behind is a transverse *optic groove* (Fig. 7), lodging the commissure of the optic nerves, terminating in

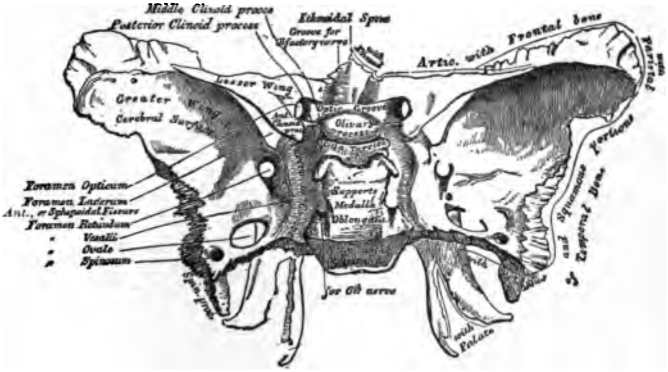

FIG. 7.—Sphenoid bone, superior surface (Gray).

two *optic foramina* for the optic nerves and ophthalmic arteries. Behind the groove is the projecting *olivary process*, forming the anterior boundary of a marked depression, the *sella turcica*, lodging the pituitary gland and circular sinus. On each side, in front, are two small projecting *middle clinoid processes*, while behind is a square-shaped plate, *dorsum sellæ*, terminating at the superior angles by the *posterior clinoid processes*, and to them are attached portions of the tentorium cerebelli. The sides of this bony plate are *notched* for the sixth pair of nerves, and the superior surface, or *dorsum*, with a broad, shallow depression, slopes obliquely downward and backward, becoming continuous with the basilar portion of the occipital bone; it supports the pons Varolii. A broad *cavernous groove* for the carotid artery and cavernous sinus exists on either side of the body. Posteriorly to the outer side of the groove is the *lingula*, and internally the *petrosal process*. The *posterior* rough quadrilateral surface articulates with the basilar portion of the occipital bone.

A vertical plate, the *sphenoidal crest* (Fig. 8), projects from the *anterior surface* of the body, forming part of the nasal septum, having the irregular openings of the *sphenoidal sinuses* on either side (absent in child), which open either into the posterior ethmoidal cells or directly into the nasal cavities. Two thin curved *sphenoidal turbinated* bones narrow these orifices to a round opening at their upper part; these plates articulate with the palate and ethmoid bones.

The *inferior surface* presents in the center the *rostrum* for the vomer, having on either side a thin plate, the *vaginal process*, articulating with the alæ of the vomer, and the *pterygo-palatine grooves*, which by articulation with the sphenoidal processes of the palate bones are converted into the *pterygo-palatine canals* for the pterygo-palatine vessels and pharyngeal nerve.

Describe the greater wings.

Two strong processes arising from the sides of the body, curving upward, outward, and backward. The concave *cerebral surface* of each wing forms part of the middle fossa of the skull, presenting a circular opening at its antero-internal part, the *foramen rotundum* for the second branch (superior maxillary) of the fifth pair of nerves; a second larger ovoidal foramen, the *foramen ovale* (Figs. 7 and 8), transmitting the third (inferior maxillary) division of the same nerve (sometimes the small petrosal nerve) and small meningeal artery, while piercing the sharp, pointed, posterior extremity of the wing, or *spinous process*, is seen a short canal (sometimes double), the *foramen spinosum*, for the passage of the middle meningeal artery, its venæ comites and the *nervus spinosus*, a recurrent branch of the inferior maxillary nerve. Occasionally the *foramen Vesalii*, on the inner side of the oval foramen, is present, transmitting a small vein.

The *external surface* presents the *infratemporal ridge* dividing the temporal from the zygomatic fossa; at its posterior part the *spinous process* (Fig. 8) gives origin to the tensor tympani muscle and the internal lateral ligament of the lower jaw.

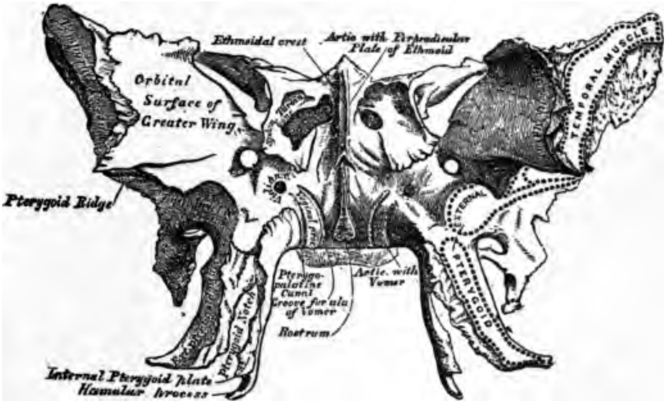

FIG. 8.—Sphenoid bone, anterior surface (Gray).

The *anterior* or *orbital surface*, smooth, quadrilateral, forming part of the outer orbital wall, is bounded above by a serrated edge for articulation with the frontal, below by a rounded border which enters into the formation of the *spheno-maxillary fissure;* internally it aids in the formation of the *sphenoidal fissure* and has a *notch* at the upper part of the inner border for a branch of the lacrimal artery; a small *spine* at its lower part, for part of the origin of the external rectus muscle; externally it presents a serrated articular margin for the malar bone, and (at times) one or more *external orbital foramina.* The *circumference* has been described above.

Describe the lesser wings.

These (processes of Ingrassias) two thin, triangular processes arise from the upper and lateral parts of the body, and project transversely outward, to terminate internally in the *anterior clinoid processes* (Fig. 7), externally in sharp points. By their anterior borders they articulate with the orbital plates of the frontal bone, while by their posterior free margins they divide the anterior from the middle cerebral fossa. Between their roots on each side is the *optic foramen* for the optic nerve and ophthalmic artery. Each inferior surface forms on either side the back part of the orbital roof, and the upper boundary of the *sphenoidal fissure*, or foramen lacerum anterius, which is bounded internally by the sphenoid body, and inferiorly by the orbital margin of the greater wing, externally by the frontal, transmitting the third, fourth, ophthalmic branch of the fifth, and sixth nerves, with the ophthalmic veins, filaments from the cavernous sympathetic plexus, also branches of the lacrimal and middle meningeal arteries, with a process of the dura mater.

Describe the pterygoid processes.

These, consisting of an *internal* and *external* plate separated behind by a notch—the *pterygoid fossa* for the internal pterygoid muscle—descend on each side perpendicularly from the junction of the greater wing with the body. At the base of the internal plate is the *scaphoid fossa*, giving origin to the tensor palati muscle, above which is the orifice of the *Vidian canal.* Internal to these is the *pterygoid tubercle*, below that a *sulcus* and a *processus tubæ* for the Eustachian tube, and then a concave edge for the superior constrictor; this plate terminates by a curved *hamular process*, around which plays the tendon of the tensor palati muscle. The external pterygoid plate has arising from its outer surface the external pterygoid muscle. The *triangular notch* below has fitting into it the tuberosity of the palate bone.

Name the bones with which the sphenoid articulates.

The other seven cranial bones and five facial, viz., the two palate, two malar, and vomer, and sometimes the two superior maxillæ.

By how many centers of ossification is this bone developed?

By fourteen centers: two for the internal pterygoid plates in *membrane*, two for the greater wings and external pterygoid plates, two for the lesser wings, two for the anterior part of the body, two for the sphenoidal turbinated bones, two for the posterior part of the body, two for the *lingulæ*, appearing from the second fetal month to the third year in *cartilage*. The bones completely unite by the twentieth year.

What muscles have their origin from the sphenoid bone?

The temporal, external and internal pterygoids, superior pharyngeal constrictor, tensor palati, levator palpebræ, obliquus superior, superior, internal, external, and inferior recti.

The Temporal Bones.

Where are they situated?

At the sides and base of the skull.

What parts does each bone present for examination?

A *squamous* (scale-like), a *mastoid* (nipple-like), and a *petrous* (stony hard) portion.

Describe the squamous portion.

The main portion is an irregularly semicircular, smooth plate, grooved posteriorly for the deep temporal arteries, convex externally, concave internally, and here grooved for the middle meningeal artery, with *digital depressions* for the cerebral convolutions. Posteriorly, a curved ridge (part of temporal) is seen. Springing from its lower part is the long, twisted, arched *zygomatic process*, arising by three roots, viz., a posterior, forming part of the temporal ridge, one running directly inward in front of the glenoid fossa, convex, covered with cartilage, forming the *eminentia articularis*, and a middle, the outer margin of the *glenoid fossa*. The obliquely transverse, *glenoid fossa* for the condyle of the lower jaw, is divided into two parts by the *Glaserian fissure* (Fig. 9), which transmits the tympanic artery, and lodges the processus gracilis of the malleus: part of the parotid gland occupies that portion posterior to the fissure. Parallel to this fissure, in the retiring angle between the squamous and petrous portions, is the opening of the *canal of Huguier* for the chorda tympani nerve. At the junction of the articular eminence with the zygomatic process is the *tubercle* for the external lateral ligament of the lower jaw.

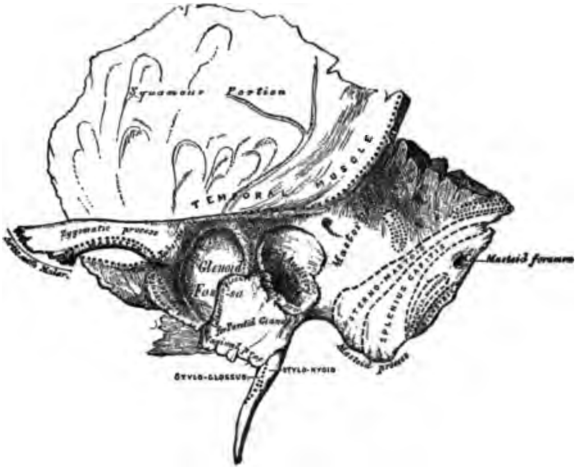

FIG. 9.—Left temporal bone, outer surface (Gray).

Describe the mastoid portion.

This projects, rough, and perforated by numerous foramina, from the postero-inferior portion of the bone—one *foramen*, the *mastoid*, transmits a vein from the lateral sinus and a small branch of the occipital artery. The interior portion of the bone contains the *mastoid cells*, lined with mucous membrane continuous with that of the tympanum. The conical tip is termed the *mastoid process*, upon whose inner side a deep grooved *digastric fossa* (Fig. 11) exists for the digastric muscle, while parallel, but more internal, lies the *occipital groove* (Fig. 11), lodging the artery of the same name. A deep *sigmoid* *fossa* (Fig. 10) exists on the inner surface of the mastoid portion for part of the lateral sinus, in which can be seen the inner orifice of the mastoid foramen.

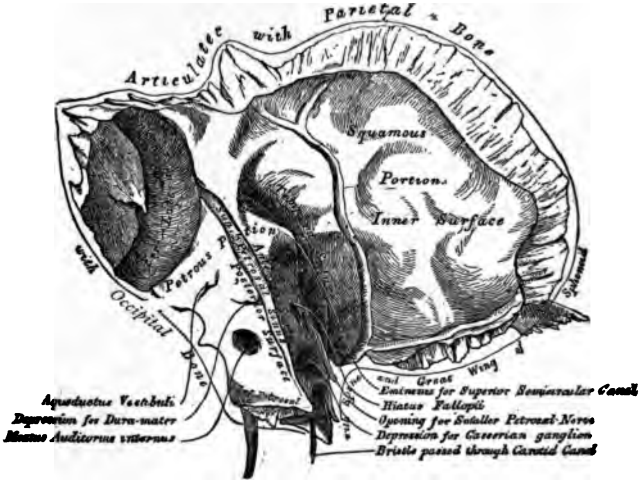
Articulates with Parietal Bone
Squamous Portion. Inner Surface
Petrous Portion
Occipital Bone
with
Sphenoid
Groove for Superior Petrosal Sinus
and Great Wing
Eminence for Superior Semicircular Canal
Hiatus Fallopii
Opening for Smaller Petrosal Nerve
Depression for Casserian ganglion
Bristle passed through Carotid Canal
Aquaeductus Vestibuli
Depression for Dura-mater
Meatus Auditorius internus

FIG. 10.—Left temporal bone, inner surface (Gray).

Describe the petrous portion.

This is a dense pyramidal mass, wedged in between the sphenoid and occipital bones, containing the organs of hearing. Its long axis is directed from without inward, forward, and a little downward. Its apex, three surfaces, and three borders must be studied. The *apex* (Fig. 10) lies in the angle formed by the posterior border of the greater sphenoidal wing and the basilar process of the occipital, forms the posterior and external boundary of the foramen lacerum, and presents the internal orifice of the carotid canal.

The *base*, its upper half covered by the squamous and mastoid portions, presents the oval, expanded orifice of the *meatus auditorius externus*, its upper margin smooth, but surrounded for the greater part of its circumference by the rough-edged (for the cartilage of the external ear), curved plate of bone called the *external auditory process*.

The *anterior surface* forming the posterior part of the middle cerebral fossa presents an *eminence*, *eminentia arcuata* (Fig. 10), near the center, indicating the situation of the vertical semicircular canal of the ear; external to this a *depression* over the tympanum, *tegmen tympani;* a shallow groove leading backward and outward to an oblique opening, the *hiatus Fallopii*, for the great superficial petrosal nerve and the petrosal branch of the middle meningeal artery; a smaller *groove* and *opening* external to the latter for the small superficial petrosal nerve; the termination of the *carotid canal* near the apex; above this canal a shallow *depression* for the Gasserian ganglion of the fifth nerve; six points of interest.

The *posterior surface* forms the anterior part of the posterior cerebral fossa, presents about its center the large orifice of the short (about four lines) *meatus auditorius internus* directed outward (closed by a vertical perforated plate, *lamina cribrosa*), which transmits the facial and auditory nerves (seventh and eighth cranial), the auditory artery, and is lined by the dura mater; behind the meatus is a small slit leading to the *aquæductus vestibuli*, transmitting a small artery and vein, and lodging a process of the dura mater. Above and between these points is the *subarcuate fossa*, which lodges a process of the dura mater and transmits a small vein.

The *inferior* (basilar) *surface*, from apex to base, presents a rough *quadrilateral surface* for the origin of the tensor tympani and levator palati muscles; the circular orifice of the *carotid canal* (Fig. 11) ascending vertically, then abruptly passing horizontally forward and inward for the passage of the internal carotid artery with its sympathetic nerve plexus; to the inner side of this—a small, triangular opening, the *aquæductus cochleæ*, transmitting a vein from the cochlea to the internal jugular; behind these openings a deep depression, the *jugular fossa* (Fig. 11), which with the jugular notch of the occipital bone forms the *jugular foramen*, transmitting the inferior petrosal and lateral sinuses and between them the ninth, tenth, and eleventh cranial nerves; a small *foramen for Jacobson's nerve*, a branch of the glosso-pharyngeal, in front of the bony ridge separating the carotid canal from the jugular fossa; on the outer wall of the jugular fossa a small *foramen for Arnold's nerve;* posterior to the jugular fossa, a square-shaped, *smooth facet* for articulation with the jugular process of the occipital; a broad, sheath-like, bony plate extending from the carotid canal to the mastoid process, the *vaginal process*, which, splitting into two laminæ, partially encloses the base of a long, sharp spine, the *styloid process*, from which arise the stylo-pharyngeus, stylo-hyoideus, and stylo-glossus muscles, and the stylo-hyoid and stylo-maxillary ligaments; between this process and the mastoid, a large orifice, the *stylo-mastoid foramen*, for the exit of the facial nerve, and the entrance of the stylo-mastoid artery; and, finally, between the vaginal and mastoid processes, the *auricular fissure* for the exit of Arnold's nerve, a branch of the pneumogastric.

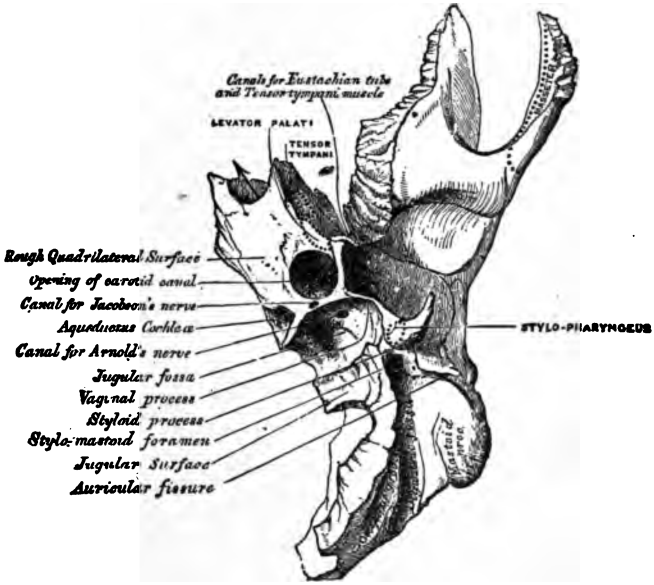

FIG. 11.—Petrous portion, inferior surface (Gray).

At the angle formed by the junction of the petrous and squamous portions two *canals* exist, separated by a thin, bony septum, the *septum tubæ*, often incorrectly called the *processus cochleariformis*, the upper lodging the tensor tympani muscle, the lower being the bony *Eustachian tube*.

What additional points of interest do the borders present?

The *superior* is *grooved* for the superior petrosal sinus, and has attached to it the tentorium cerebelli; the *posterior* has a *half-groove* which, with another on the occipital, accommodates the inferior petrosal sinus.

From how many centers is this bone developed?

From ten: one for the squamosal and zygoma (in membrane), four for the petrous, two for the mastoid, two for the styloid, and one for the tympanic plate (all the latter in cartilage), from the eighth fetal week to the sixth fetal month—bone coössifies in the first year, except the styloid process.

With what bones does each temporal articulate?

The occipital, one parietal, sphenoid, one malar, and the inferior maxillary; five bones.

What muscular attachments has it?

Squamosal, the temporal; *zygoma*, the masseter; the *mastoid portion* and *process*, the occipito-frontal, sterno-mastoid, splenius capitis, trachelo-mastoid, digastricus, and retrahens aurem. *Styloid*, the stylo-pharyngeus, stylo-hyoideus, stylo-glossus. *Petrous*, the levator palati, tensor tympani, tensor palati, and stapedius; fifteen in all.

The Ethmoid Bone.

Of what parts does this bone consist?

Of a *horizontal cribriform plate*[3] (sieve-like), of two *lateral masses*[10] of cells depending from this on either side (Fig. 12), between which lies the *perpendicular plate*[2] forming part of the septum of the nose; the whole bone is of a cuboidal form.

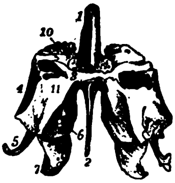

FIG. 12.—Ethmoid bone, posterior view.

Describe the cribriform plate.

Springing from the upper surface is the *crista galli*[1] (cock's-comb), a vertical plate running from before backward, whose anterior border is notched to complete the foramen cæcum of the frontal bone. Two deep, longitudinal *olfactory grooves*, for the olfactory bulbs, lie on either side, their floors perforated by three rows of small foramina, for filaments of the olfactory nerves;

and on each side in front is a small slit for the nasal branch of the ophthalmic nerve; the crest gives attachment to the falx cerebri.

Describe the perpendicular plate (Figs. 12 and 14).

It is thin, usually deflected to one or other side, forms part of the nasal septum, and has upon each side numerous grooves and canals to accommodate the olfactory nerve filaments.

Of what are the lateral masses formed? (Figs. 12 and 13).

Of thin-walled cavities, the *ethmoidal cells*, three sets, whose outer limits make the *os planum*[4], while their inner walls form part of the nasal fossæ; above they are *grooved* to form with grooves on the frontal the two ethmoidal foramina. The upper outer margins of each mass present a number of half-cells completely closed in when articulated with the ethmoidal notch of the frontal bone; posteriorly are also half-cells completed by the sphenoidal turbinated and palate bones; again, in front and below, the cells are completed by the lacrimal and superior maxillary bones; inferiorly an irregular hook-like plate projects, the *unciform process*[5], which closes in the upper part

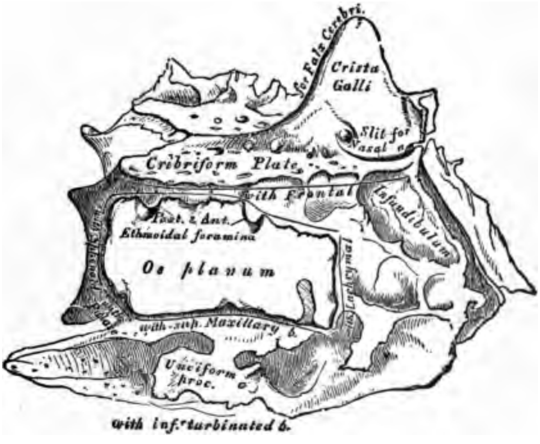

FIG. 13.—Ethmoid bone, outer surface of right lateral mass (enlarged) (Gray).

of the orifice of the antrum. A narrow, oblique fissure, the *superior nasal meatus*, subdivides the inner surface, bounded above by the thin curved *superior turbinated bone*[6], below by the convex scroll-like *middle turbinated bone*[7]; the *posterior cells* open into the upper part of this fissure, the *anterior* and *middle* open into the frontal sinus above, and into the *middle nasal meatus* below, by the flexuous *infundibulum*. The middle meatus is bounded above by the middle turbinated bone.

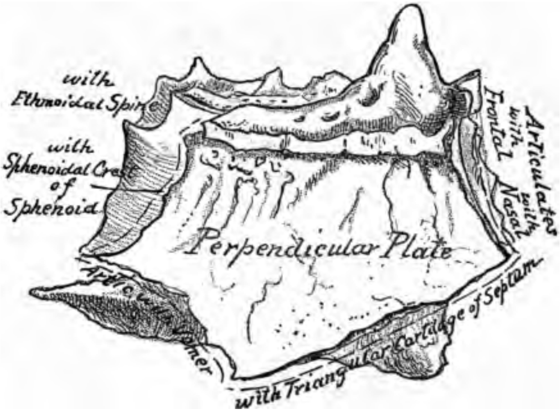

FIG. 14.—Perpendicular plate of ethmoid (enlarged), shown by removing the right lateral mass.

How many centers of ossification has this bone?

Three: one for each lateral mass (fourth to fifth fetal month); one for the perpendicular and cribriform plates in *cartilage* during the first year; the ethmoidal cells, completing the bone, form about the fourth or fifth year.

With how many bones does it articulate?

Fifteen: the sphenoid, two sphenoidal turbinated, frontal, two nasal, two superior maxillary, two lacrimal, two palate, two inferior turbinated, and the vomer. No muscles are attached.

The Nasal Bones.

Describe them.

They are of oblong form, their *outer* surfaces concave from above downward, convex from side to side, marked by many small arterial furrows and usually presenting at their centers a single or double venous foramen. Their *inner* surfaces are convex from above downward and concave from side to side, traversed longitudinally by a *groove*, sometimes a *canal*, for a branch of the nasal nerve which escapes by a notch about the middle of the lower thin margin. Each bone presents four borders.

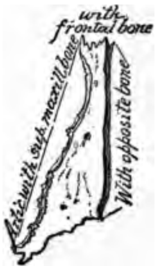

FIG. 15.—Right nasal bone, outer surface.

(Gray.)

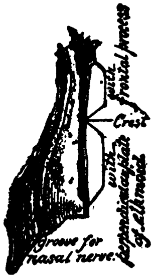

FIG. 16.—Left nasal bone, inner surface.

With what bones does each nasal bone articulate?

With the frontal, ethmoid, its fellow nasal, and the superior maxillary. It has no muscular attachments.

How is each developed?

From one center in membrane (eighth fetal week).

The Superior Maxillary Bones.

Describe them.

They each consist of a hollow body and four processes; together they form the whole upper jaw.

Describe the body.

It is cuboidal in form and hollowed out into a pyramidal cavity, *the antrum of Highmore* (Fig. 18). Of its four *sur-*

faces, the *external* (facial), directed forward and outward, presents, just above the incisor teeth, the *incisive* (myrtiform) *fossa* (Fig. 17), more externally the larger *canine fossa*, separated from the former by the *canine eminence* formed by the socket of the canine tooth; above this is the *infra-orbital foramen*, giving egress to the infra-orbital artery and nerve; and above this surface is the margin of the orbit.

The *posterior surface* is convex, forms part of the zygomatic fossa, has about its center several apertures of the *posterior dental canals* for the dental vessels and nerves; at its lower part (especially after the wisdom tooth is formed) is a rounded eminence, the *maxillary tuberosity* (Fig. 17), which articulates by its rough inner surface with the tuberosity of the palate bone; and just above the rough surface is an oblique *groove* running down on the inner side, which by the apposition of the palate bone forms the *posterior palatine canal* (Fig. 18).

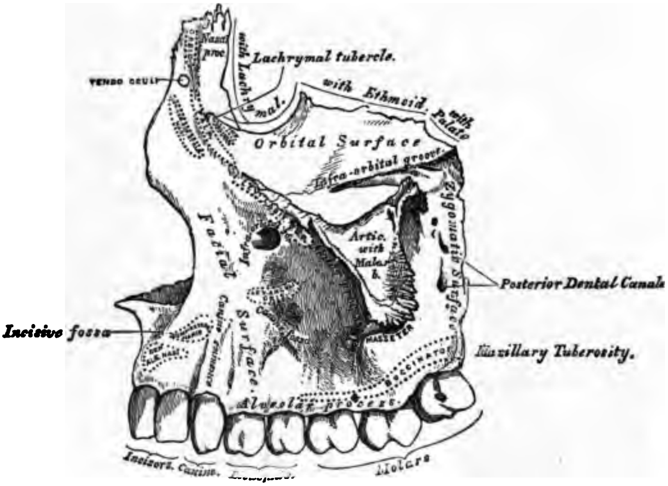

FIG. 17.—Left superior maxillary bone, outer surface (Gray).

The *superior* (orbital plate) *surface*, thin, smooth, and triangular, forms part of the floor of the orbit, articulates internally by an irregular margin (from behind forward) with the palate bone, os planum of the ethmoid and lacrimal; externally, by its smooth, rounded edge, it helps to form the spheno-maxillary fissure (sometimes articulating in front with the orbital plate of the sphenoid); anteriorly it forms part of the orbital margin. At the middle of the outer border of this surface is the deep *infra-orbital groove* (Fig. 17), which in front becomes a *canal* of the same name, opening by the infra-orbital foramen; small canals branching from this pass into the substance of the anterior wall of the antrum—the *anterior* and *middle dental canals;* at the inner forepart of this orbital surface are a *lacrimal notch* and a minute *depression* for the origin of the inferior oblique muscle of the eye.

The *internal surface*, unequally divided horizontally into two parts by the *palate process* (Fig. 18), forms above this part of the outer wall of the nasal fossæ; below, a portion of the mouth. The nasal surface presents a large irregular opening into the antrum, above which are irregular cellular cavities closed in, when articulated, by the ethmoid and lacrimal bones. Below the opening is the smooth surface forming part of the inferior meatus of the nose; behind, a *rough surface* for the palate bone with a groove passing from above downward and forward, the *posterior palatine*, which, closed in by the

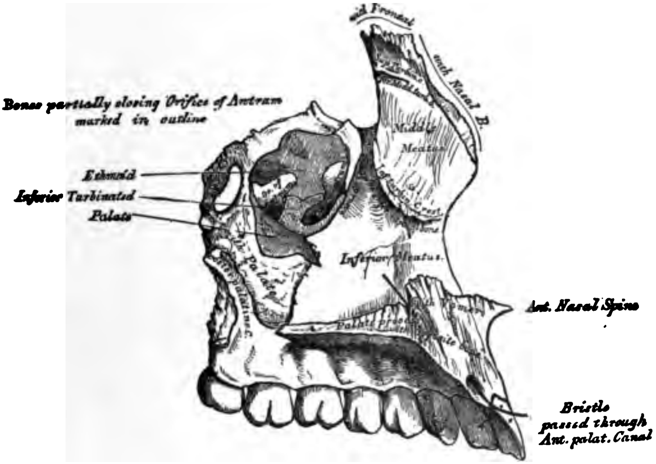
and Frontal
and Nasal B.
Bones partially closing Orifice of Antrum marked in outline
Ethmoid
Inferior Turbinated
Palate
Middle Meatus
Inferior Meatus
Ant. Nasal Spine
Bristle passed through Ant. palat. Canal

FIG. 18.—Left superior maxillary bone, inner surface (Gray).

palate bone, forms the posterior palatine canal; in front, a deeper vertical groove, which by the apposition of the lacrimal and inferior turbinated bones forms the *lacrimal canal* for the nasal duct; and still more anteriorly the well-marked horizontal, *inferior turbinated crest*, for the inferior turbinated bone.

Describe the antrum of Highmore (maxillary sinus).

It is triangular, with its apex directed outward formed by the malar process, its base forming the outer nasal wall, and opens, in the fresh state, by a small orifice of the size of a probe point into the middle nasal meatus. In the non-articulated bone there is a large irregular opening, which is narrowed when articulated by portions of the palate, ethmoid, inferior turbinated, and sometimes the lacrimal bones. On its posterior walls are the *posterior dental canals*, while its floor presents several conical *prominences*, produced by the fangs of the first and second molar teeth; sometimes the floor is actually perforated. The walls are very thin.

Describe the malar process.

It is a rough, triangular eminence, concave on its facial and zygomatic surfaces, and roughly serrated above for the malar bone.

Describe the nasal process.

This is thick and triangular, rising upward, inward, and backward, with an *external* concave smooth *surface*, an *internal surface* articulating with the frontal above and by a rough surface with the ethmoid; below this is the transverse ridge-like *superior turbinated crest* for the middle turbinated bone. Next comes a smooth, concave surface, part of the middle nasal meatus; then the inferior turbinated crest (see *ante*); and, most inferior of all, the concavity forming part of the inferior nasal meatus. The *anterior border* is thin and serrated for articulation with the nasal bone; the *posterior border* is thick, and grooved for the lacrimal duct, which is directed *backward and a little outward;* where the outer margin of the groove joins the orbital surface is the *lacrimal tubercle.*

Describe the alveolar process.

This is thick and spongy, with eight cavities of varying depth, that for the canine tooth being deepest, and those for the molars widest and subdivided.

Describe the palate process.

It is a horizontal plate (Figs. 18 and 19), thickest in front, forms most of the roof of the mouth and floor of the nostril; has an upper and a lower concave surface. In front, upon the upper surface, is the upper orifice of the *anterior palatine canal*, which leads to a fossa formed between the two bones, transmitting the anterior palatine vessels through the *foramina of*

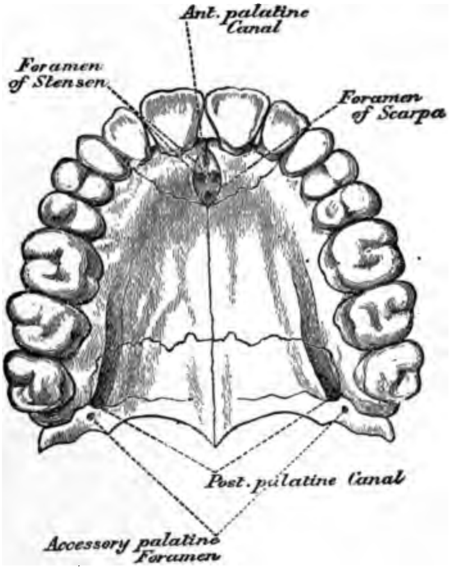

FIG. 19.—The palate and alveolar arch (Gray).

Stensen, the naso-palatine nerves passing through the intermaxillary suture by the *foramina of Scarpa;* upon the under surface is a longitudinal *groove* (sometimes a canal), leading from the posterior palatine canal, for the posterior palatine vessels and nerve, while in front is seen the lower orifice of the *anterior palatine fossa* presenting four openings; the inner border is thickened into a ridge on the upper surface, forming the *nasal crest*, which runs higher in front, called the *incisor crest*, and then forms the *anterior nasal spine.*

How is this bone developed?

Probably by four centers; it develops so early, immediately after the clavicle and mandible, that its number of centers is uncertain. There seem to be the malar portion, orbito-facial, palatine, and a premaxillary carrying the incisor teeth. The antrum commences at the fourth fetal month.

With what bones does it articulate?

With the frontal, ethmoid, nasal, malar, lacrimal, inferior turbinated, palate, vomer, with the other superior maxillary, and sometimes with the sphenoid.

Give the muscular attachments.

Orbicularis palpebrarum, obliquus oculi inferior, levator labii superioris alæque nasi, levator labii superioris, levator anguli oris, compressor nasi, depressor alæ nasi, dilator naris posterior, masseter, buccinator, internal pterygoid, and orbicularis oris.

The Lacrimal Bones.

What is their shape and where are they situated?

They are two small bones situated at the front part of the inner wall of the orbit, resembling in form, thinness, and size a finger-nail, hence called *os unguis.* The *external orbital surface* presents a vertical *ridge* giving origin to the tensor tarsi muscle, in front of which is a concave longitudinal *groove* forming part of the *lacrimal canal* below, lodging the lacrimal sac above. Below is the *hamular process* articulating with the superior maxillary bone, assisting to form the lacrimal canal. A depressed furrow is seen on the *nasal surface* corresponding to the ridge externally; the surface in front forming part of the middle nasal meatus, the posterior closing in the anterior ethmoidal cells. This bone also presents *four borders.*

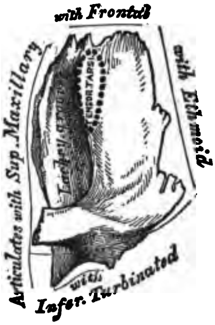

FIG. 20.—Left lacrimal bone, external surface (enlarged) (Gray).

With what bones does it articulate?

With the frontal, ethmoid, superior maxillary, and inferior turbinated.

How is it developed?

From one center in membrane, at the eighth fetal week. The tensor tarsi muscle of Horner is attached to it.

The Malar Bones.

Describe them.

Two small quadrangular bones placed at the upper outer part of the face, forming the prominence of the cheek, and parts of the orbital, temporal, and zygomatic fossæ. The *external surface* (Fig. 21) is convex, smooth, and perforated by one or more *malar foramina;* just below the center the *malar tuberosity* gives origin to the two zygomatic muscles. The *internal surface* looks into the temporal and zygomatic fossæ and articulates with the superior maxilla (Fig. 22). Superiorly a thick serrated *frontal process* articulates with the external angular process of the frontal bone; a thick, plate-like *orbital process* projecting backward, smooth and concave internally, forms part of the floor and outer wall of the orbit; convex below, it forms part of the temporal fossa. It bounds the anterior extremity of the spheno-maxillary fissure. Its upper surface shows the orifices of one or more *temporo-malar canals* for filaments of the orbital branch of the superior maxillary nerve. Externally, projecting backward is the *zygomatic process*, articulating with the zygomatic process of the temporal bone by a serrated margin. The *maxillary process* points downward and articulates with the superior maxilla.

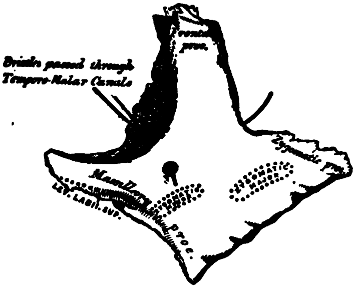

Fig. 21.—Left malar bone, outer surface.

(Gray.)

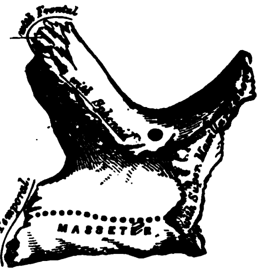

Fig. 22.—Left malar bone, inner surface.

The *antero-superior border*, smooth and arched, forms the outer and inferior margin of the orbit; the *antero-inferior border*, roughly bevelled, articulates with the superior maxilla; the *postero-superior border*, like an italic *f*, is continuous above with the temporal ridge, below with the upper border of the zygoma; the *postero-inferior border*, thick and rough, gives origin to the masseter muscle.

How is it developed?

From three centers, which unite at the fourth fetal month. It articulates with the frontal, sphenoid, temporal, and superior maxillary bones.

What muscles arise from it?

The levator labii superioris, zygomaticus major and minor, masseter, and temporal.

The Palate Bones.

Describe them.

These two bones, situated at the back part of the nasal fossæ, assist in the formation of the floor and outer wall of the nose, the roof of the mouth, the floor of the orbit, and the inner wall of the antrum, and aid in forming the spheno-maxillary and pterygoid fossæ and the spheno-maxillary fissure.

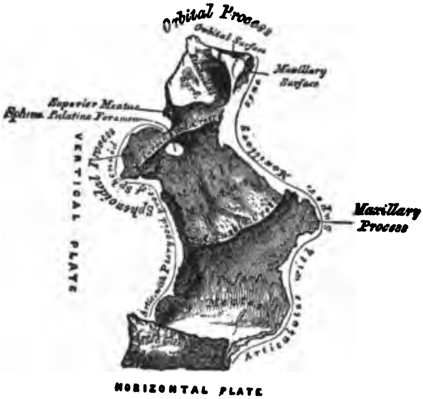

FIG. 23.—Left palate bone, internal view (Gray).

Of what parts does each bone consist?

Of a *vertical plate*, a *horizontal plate*, and three processes, the *pterygoid*, *sphenoidal*, and *orbital* (Figs. 23 and 24).

Describe the points on the vertical plate.

This thin oblong plate, directed upward and a little inward, presents *internally* at its upper part the *superior turbinated crest;* lower, a second ridge, the *inferior turbinated crest*, for the middle and inferior turbinated bones, between which lies the *groove* for the middle nasal meatus; below the inferior crest is another *groove*, for the inferior meatus. The *posterior border* articulates with the pterygoid process of the sphenoid; on the *external surface* is a deep *groove* forming the posterior palatine canal by articulation with the superior maxilla, transmitting the vessels and nerve of the same name; the upper and back part of this surface helps to form the inner wall of the spheno-maxillary fossa. The *anterior border* sends forward a small lamina of bone opposite the inferior turbinated crest, the *maxillary process*, which narrows the orifice of the antrum. The *posterior border* at the lower portion is pyramidal, forming the *pterygoid process*, which is deeply *grooved*, forming part of the pterygoid fossa, with a V-shaped rough margin for articulation with the pterygoid plates.

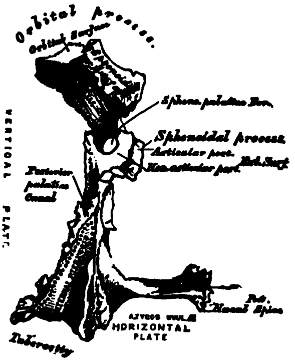

FIG. 24.—Left palate bone, posterior view (Gray).

The *superior border*, deeply notched by the *spheno-palatine foramen* (or notch), presents two processes. The *orbital process* in front articulates *anteriorly* with the maxilla, *posteriorly* with the sphenoid (its cells here usually opening into the sphenoidal sinus), *internally* with the ethmoid, and has a free *orbital* and *zygomatic* surface, the latter looking into the zygomatic fossa, with a *rounded border* forming part of the spheno-maxillary fissure; behind, projecting upward and inward, is the *sphenoidal process*, *grooved* on its upper surface by a *pterygo-palatine* *groove* to help to form the same-named canal; articulating here with the sphenoid bone externally and posteriorly with the pterygoid process, and having an internal concave surface forming part of the outer wall of the nasal fossa.

Describe the horizontal plate.

This, completing the nasal floor and hard palate, presents on its inferior surface a transverse *ridge* for the tensor palati aponeurosis, a deep *groove* assisting in the formation of the posterior palatine canal; near this the orifices of one or two *accessory posterior palatine canals;* an *anterior border*, serrated and bevelled for the palate process of the superior maxilla; a smooth concave *posterior border* for the attachment of the soft palate, terminating in the median line by a projection, which with its fellow on the other bone forms the *posterior nasal spine* for the azygos uvulæ muscle; and an *internal* thick *border*, whose upper edge is raised to form with its fellow a *crest* articulating with the vomer.

How is this bone developed?

By one center *in membrane* at the angle of junction of the two plates (seventh to eighth fetal week).

With what bones does it articulate?

The sphenoid, sphenoidal turbinated, ethmoid, superior maxillary, inferior turbinated, vomer, and opposite palate.

Give the muscular attachments.

Tensor palati. azygos uvulæ, internal pterygoid, and superior constrictor of the pharynx.

The Inferior Turbinated Bones.

Describe them (Figs. 25 and 26).

They are two thin, scroll-shaped bones, extended horizontally along the outer walls of the nasal fossæ, just below the orifice of the antrum, and are attached to the inferior turbinated crests of the superior maxillary and palate bones, and present three processes for study: a *lacrimal*, in front of the upper border, forming part of the lacrimal canal by its junction with the lacrimal and superior maxillary bones; further back, the *ethmoidal process*, joining the unciform process of the ethmoid; and from the lower border of this process the *maxil-*

lary process projects, curving downward and hooking over and narrowing the orifice of the antrum. The outer surface (from the median plane of the head) is concave; its inner, convex, roughened, and grooved for arteries and veins.

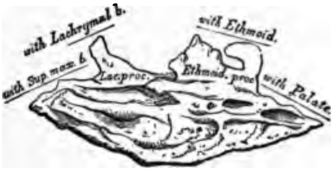

Fig. 25.—Right inferior turbinated bone, internal surface. (Gray.)

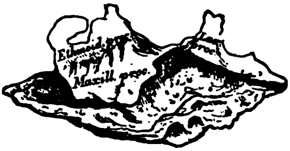

Fig. 26.—Right inferior turbinated bone, external surface.

Name the bones with which it articulates, and its method of development.

It *articulates* with the ethmoid, lacrimal, palate, and superior maxillary bones; it is developed by one center *in cartilage* (fifth fetal month). No muscles are attached.

The Vomer.

Describe it.

It is a single bone shaped like a plowshare, placed vertically in the nasal fossæ (usually deviated to one side), and forms part of the nasal septum. Its *superior border* is deeply *grooved* for the rostrum of the sphenoid, with lateral *wings* (alæ), each of which meets the vaginal process of the pterygoid process. The

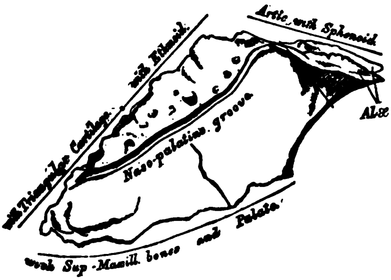
Artic. with Sphenoid
with Ethmoid
with Triangular Cartilage
Naso-palatine. groove
Alæ
with Sup.-Maxill. bones and Palate.

Fig. 27.—The vomer (Gray).

anterior border is grooved for the vertical plate of the ethmoid and the nasal septal cartilage. The *inferior border* is received in the groove formed by the nasal crest of the superior maxillary and palate bones. The *posterior border* is free, concave, thick above and thin below, and separates the nasal fossæ behind. On each lateral surface is the *naso-palatine groove* (sometimes a canal) for the nerve of the same name, and also small *furrows* for the lodgement of blood-vessels.

Name the bones with which it articulates, and its centers of ossification.

The sphenoid, ethmoid, both superior maxillary, and both palate bones. It has two centers (eighth fetal week *in membrane*), which unite below, but form two laminæ above; ossification is not completed until after puberty. No muscles are attached.

The Inferior Maxillary Bone, or Mandible.

Enumerate its general characteristics.

It consists of a *body*, with two *rami*, which are surmounted on either side by a thin triangular *coronoid process* in front, and an articular *condyloid process* posteriorly; the constricted portion beneath the condyle is termed the *neck* of the condyle; the depression separating these two processes is called the *sigmoid notch*, crossed by the masseteric vessels and nerve.

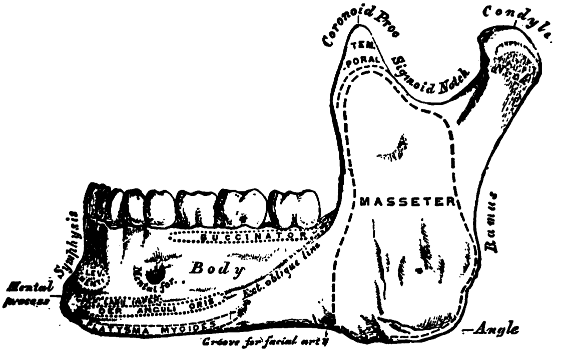

FIG. 28.—Inferior maxillary bone, outer surface, side view (Gray).

Describe the body of the bone (Fig. 28).

It is horseshoe-shaped, and presents a triangular eminence in front, the *mental process*, with a *mental tubercle* on each side; extending upward is a median vertical ridge, the *symphysis*, marking the junction of the two halves of the bone; on either side, just below the roots of the incisor teeth, is the *incisor fossa*, giving origin to the levator menti; and more externally, below the interval between the two bicuspid teeth, the *mental foramen* for the exit of the mental vessels and nerve. Extending outward from the base of the mental process is a distinct *ridge*, the *external oblique line*, continuous posteriorly with the anterior border of the ramus; to it are attached anteriorly the depressor labii inferioris and the depressor anguli oris. The lower border, just in front of the attachment of the masseter, is *grooved* for the facial artery. The *internal surface* (Fig. 29)

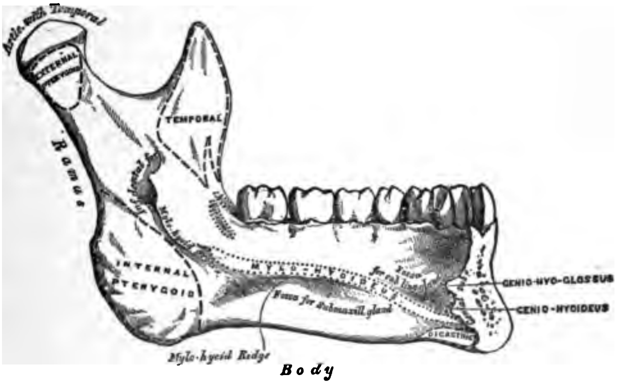

FIG. 29.—Inferior maxillary bone, inner surface, side view (Gray).

presents an indistinct *linear depression*, indicating the point of junction of the two halves of the bone, on either side of the center of which are two prominent *genial tubercles*, disposed in pairs, sometimes blended into two, or even one irregular mass, the upper giving origin to the genio-hyo-glossi, the lower pair to the genio-hyoidei muscles. Upon each side of these tubercles is the oval *sublingual fossa* for the gland similarly named, and beneath each is a rough *depression* for the origin of the digastric muscle. Extending obliquely upward and backward from the sublingual fossa is the *internal oblique line* (mylohyoid ridge) for the same-named muscle; beneath its edge is the oblong *submaxillary fossa* for the submaxillary gland; above it is the alveolar portion, hollowed into alveoli (sockets) for sixteen teeth in the adult, ten in the child.

Describe the rami.

These ascending, flattened, quadrilateral plates present in front the curved *coronoid process*, giving attachment to the temporal muscle by its apex, margins, and inner surface; next come the *sigmoid notch* and the *condyle* surmounting its narrow *neck*, in front of which is a depression for the tendon of the external pterygoid muscle, and externally a small *tubercle* for the external lateral ligament. The articular surface is oblong, with its long axis transversely oblique from behind forward and outward, and is convex from behind forward and from side to side. Upon the inner surface of the coronoid process commences a longitudinal *ridge*, with a *groove*, for the temporal above, the buccinator muscle below. The outer surface of the ramus has various *ridges* for the attachment of the masseter muscle; its inner surface presents a central oblique aperture, that of the *inferior dental canal* (communicating with each alveolus and terminating at the mental foramen) for the vessels and nerve; in front of this opening is a prominent *ridge*, terminating behind in a sharp *spine*, or *lingula*, for the long internal lateral ligament; below the spine is the *mylo-hyoid groove* for the same-named vessels and nerves; and behind the groove is a *rough surface* for the internal pterygoid muscle.

At the junction of the posterior and the inferior margins of the ramus is the *angle*, marked with rough oblique ridges, externally for the masseter, internally for the internal pterygoid muscle.

With what bones does the inferior maxillary articulate?

With the two temporals.

What ossific centers has it?

It is the second bone of the skeleton to ossify (clavicle first), and is probably developed by several centers for each lateral half, chiefly in *membrane*, partly in *cartilage*, which coössify about the first year.

Compare the forms of the old and the adult jaw.

In old age, the alveolar portion being absorbed, the angle formed by the ramus with the body is very obtuse, and the dental canal is near the upper surface (important surgically in operating for neuralgia); in adult age the ramus is almost vertical, and the dental canal lies about the middle of the bone.

Give the muscular attachments.

Fifteen pairs: to each *ramus*, the masseter, temporal, internal and external pterygoid; to the *inner surface* of the *body*, the genio-hyoglossus, genio-hyoid, mylo-hyoid, digastric, and superior pharyngeal constrictor; to the *outer surface* of the body the levator menti, depressor labii inferioris, depressor anguli oris, orbicularis oris, platysma myoides, and buccinator.

The Sutures and Fontanelles.

What is a suture?

A line of interlocking, tooth-like processes, projecting from the *external* tables of the skull bones (the inner tables are merely apposed). Sutures are joints of the immovable class, synarthrosis, and subclass syndesmosis, being united by close ligaments. They are nineteen in number.

Name those at the vertex.

The interparietal (sagittal), the fronto-parietal (coronal), and the occipito-parietal (lambdoid).

Name those at the sides.

The spheno-parietal, the squamo-parietal, and the masto-parietal.

Name those at the base.

One basi-sphenoidal, two petro-occipital, two masto-occipital, two petro-sphenoidal, and two squamo-sphenoidal. The points of junction of the sphenoid with the frontal and ethmoid, and of the frontal with the ethmoid, are not usually described as sutures.

Which only of the facial sutures has received a name?

The *transverse*, that extending from one external angular process of the frontal to the other, joining that bone with the malar, sphenoid, ethmoid, lacrimal, superior maxillary, and nasal bones.

Why does the skull consist of so many pieces?

To admit of continuous growth of the bones at their edges, pari passu with the growth of the brain; hence premature co-ossification of all the sutures results in *idiocy.* Obliteration of the sutures occurs at variable periods after maturity.

What are the fontanelles?

They are membranous intervals in the infant's skull, corresponding to the junction of the four angles of the parietal with the contiguous bones. They number six, viz., the *anterior*, of lozenge-shape, at the junction of the sagittal and coronal sutures, usually closed not later than the second year; the *posterior*, triangular, at the junction of the sagittal and lambdoid sutures, closed a few months after birth; and the *lateral*, one at the antero-inferior angle, another at the postero-inferior angle of each parietal bone, which are closed soon after birth.

How are these spaces closed?

By a gradual extension of the ossifying process, or by the development of additional centers, forming the so-called *Wormian bones.*

THE SKULL AS A WHOLE.

The Cerebral Fossæ.

Describe the general characteristics of the anterior fossa with its foramina (Fig. 30).

Formed by the orbital plates of the frontal, the cribriform plate of the ethmoid and crista galli, the lesser wings and part of the body of the sphenoid, it is convex on either side and concave in the median line. The foramina are one median, the *foramen cæcum*, which, if pervious, transmits a vein from the superior longitudinal sinus to the nose; one *slit* on each side of the crista galli for the nasal nerve; three rows of olfactory foramina on each side for the olfactory filaments; on the outer side of each olfactory groove the *anterior* and the *posterior ethmoidal foramina*, the former transmitting the anterior ethmoidal artery and the nasal nerve, the latter, the posterior ethmoidal artery and vein.

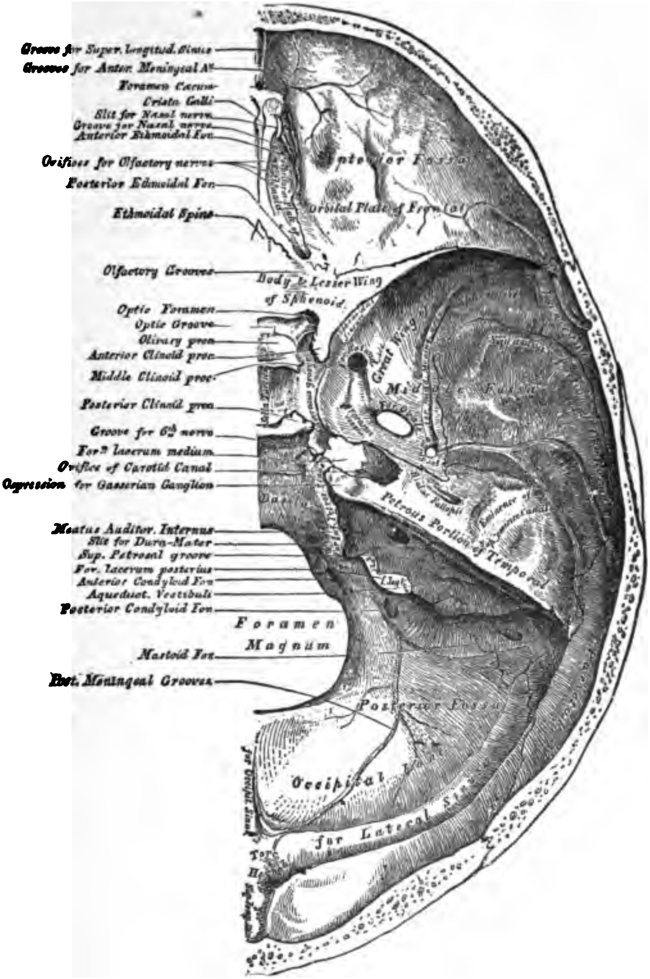

FIG. 30.—Base of the skull, inner or cerebral surface (Gray).

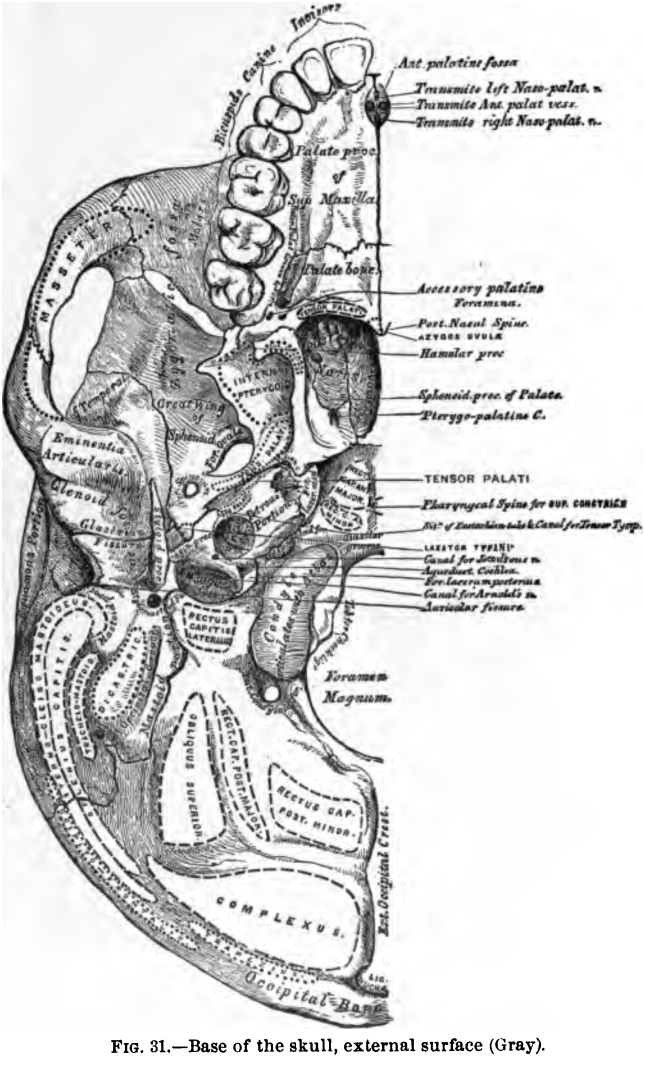

FIG. 31.—Base of the skull, external surface (Gray).

buli for a small artery and vein; the *subarcuate fossa;* the *foramen lacerum posterius* transmitting the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, the inferior petrosal and lateral sinuses, and the meningeal branches of the ascending pharyngeal and occipital arteries; the *mastoid foramen* for a vein and artery; the *posterior condyloid foramen* (inconstant) for a vein; the *anterior condyloid foramen* for the hypoglossal nerve, and a meningeal branch from the ascending pharyngeal artery: and in the floor of the fossa in the median line is the *foramen magnum*, accommodating the medulla oblongata and membranes, the spinal accessory nerves, and the vertebral arteries.

What additional foramina or openings are found at either side of the base of the cranium (Fig. 31)?

The *orifice of the Eustachian tube*, admitting air to the middle ear. The *canal for the tensor tympani muscle* above the former, separated from it by the *septum tubæ*, the posterior end of which is the *processus cochleariformis.* The *posterior orifice of the Vidian canal*, for the Vidian nerve and vessels. *Glaserian fissure* for the processus gracilis of the malleus, and the tympanic branch of the internal maxillary artery. The *orifice of the canal of Huguier*, transmitting the chorda tympani nerve. The *canal for Jacobson's nerve*, the tympanic branch of the glosso-pharyngeal. The *aquæductus cochleæ*, for a small artery and vein running to and from the cochlea. The *canal for Arnold's nerve*, the auricular branch of the pneumogastric. The *auricular fissure*, for the exit of Arnold's nerve. The *stylo-mastoid foramen*, for the exit of the facial nerve and the entrance of the stylo-mastoid artery.

The *anterior* and the *posterior* foramina of the palatal region have already been sufficiently described, and this region does not properly belong to the *base of the cranium;* while those opening externally at the *base* and upon the *face* have been described sufficiently under the temporal bone and the superior and inferior maxillary bones.

The Orbital Cavities.

Describe them (Figs. 32 and 33).

They are two quadrilateral pyramidal cavities, with bases outward, their long axes directed from the front inward and

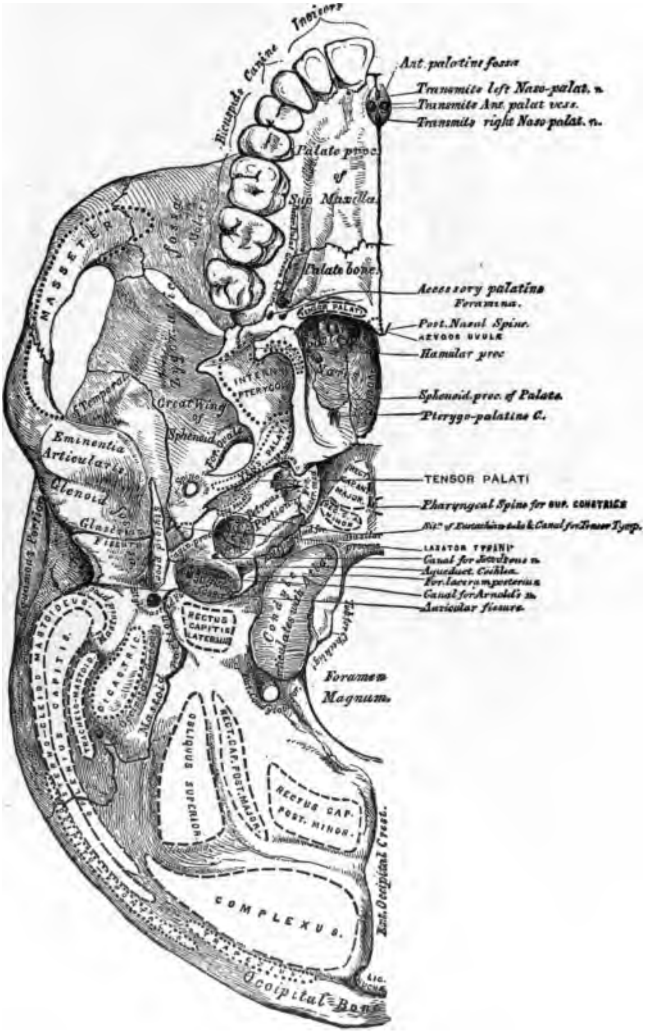

FIG. 31.—Base of the skull, external surface (Gray).

backward, in such directions that if prolonged they would meet about the sella turcica of the sphenoid. Seven bones contribute to the formation of each, viz., the frontal^{1}, the ethmoid^{27}, the sphenoid^{23}, the lacrimal^{24}, the superior maxillary^{6}, the palate^{25}, and the malar^{22}; each communicates with the *cranial cavity* behind by the optic foramen^{18} and the sphenoidal fissure^{23}, with the *nasal fossa* through the canal of the nasal duct, and below externally by the spheno-maxillary fissure^{25} with the *temporal*, *zygomatic*, and *spheno-maxillary fossæ*.

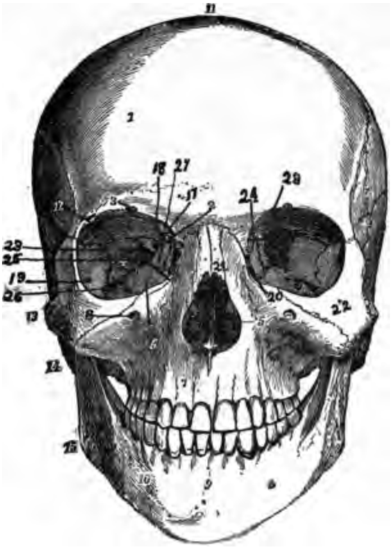

FIG. 32.—Anterior region of the skull (Leidy).

What bones compose the roof, and what is its form?

The orbital plate of the frontal anteriorly, the lesser sphenoidal wing behind; it is concave and directed downward and forward, presenting internally a *depression*^{28} for the fibro-cartilaginous pulley of the superior oblique muscle of the eye, and externally the *lacrimal fossa*^{12} for the lacrimal gland.

Describe the floor.

Nearly flat, formed chiefly by the orbital plate of the superior maxillary[6], and to a less extent by the orbital processes of the malar[19] and palate bones; it presents just external to the lacrimal canal a *depression* for the inferior oblique muscle; externally, the *malo-maxillary suture;* near the middle, the *infra-orbital groove;* and posteriorly, the *palato-maxillary suture.*

Name the bones forming, and the points of interest upon the inner wall.

It is flattened, formed by the nasal process of the superior maxillary, the lacrimal[24], os planum of the ethmoid[27], and the sphenoidal body. It presents in front the *lacrimal groove*[20], bounded behind by the *lacrimal crest;* further back respectively the *lacrimo-ethmoidal* and *ethmo-sphenoidal sutures.*

What forms the outer wall?

The orbital plate of the malar and the greater wing of the sphenoid, and on it are seen the openings of one or two *malar canals*[19] and the *spheno-malar suture.*

Describe the superior external angle of the orbit.

Posteriorly, the *sphenoidal fissure* (foramen lacerum anterius)[23] for the *entrance* of the third, fourth, three branches of the ophthalmic division of the fifth and sixth nerves, and branches of the middle meningeal artery, a process of the dura mater, sympathetic nerve filaments, and the *exit* of the ophthalmic veins, and a recurrent branch from the lacrimal artery. This angle also shows the *fronto-malar* and the *fronto-sphenoidal sutures.*

What points does the superior internal angle present?

The suture between the lacrimal, ethmoid, and frontal bones; between the junction of the two latter bones the *anterior ethmoidal foramen*[2] for the anterior ethmoidal vessels and nasal nerve, and the *posterior ethmoidal foramen*[17] for the posterior ethmoidal vessels.

What points does the inferior external angle present?

The *spheno-maxillary fissure*[26] transmitting the infra-orbital vessels and superior maxillary nerve, the ascending branches from the spheno-palatine ganglion, and the orbital branch of the superior maxillary nerve.

How is the inferior internal angle formed?

By a *suture*, the union of the lacrimal and os planum of the ethmoid with the superior maxillary and palate bones.

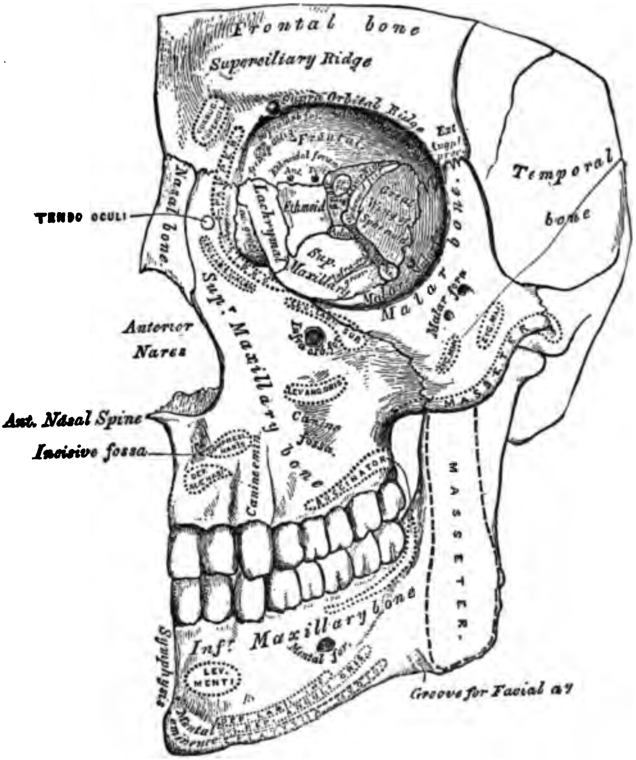

FIG. 33.—Anterior region of the skull (Gray).

What foramen does the orbital margin present?

The *supra-orbital*[3] at the junction of the inner and middle thirds, transmitting the supra-orbital artery, veins, and nerve.

Describe the floor.

Nearly flat, formed chiefly by the orbital plate of the superior maxillary[6], and to a less extent by the orbital processes of the malar[19] and palate bones; it presents just external to the lacrimal canal a *depression* for the inferior oblique muscle; externally, the *malo-maxillary suture;* near the middle, the *infra-orbital groove;* and posteriorly, the *palato-maxillary suture.*

Name the bones forming, and the points of interest upon the inner wall.

It is flattened, formed by the nasal process of the superior maxillary, the lacrimal[24], os planum of the ethmoid[27], and the sphenoidal body. It presents in front the *lacrimal groove*[20], bounded behind by the *lacrimal crest;* further back respectively the *lacrimo-ethmoidal* and *ethmo-sphenoidal sutures.*

What forms the outer wall?

The orbital plate of the malar and the greater wing of the sphenoid, and on it are seen the openings of one or two *malar canals*[19] and the *spheno-malar suture.*

Describe the superior external angle of the orbit.

Posteriorly, the *sphenoidal fissure* (foramen lacerum anterius)[23] for the *entrance* of the third, fourth, three branches of the ophthalmic division of the fifth and sixth nerves, and branches of the middle meningeal artery, a process of the dura mater, sympathetic nerve filaments, and the *exit* of the ophthalmic veins, and a recurrent branch from the lacrimal artery. This angle also shows the *fronto-malar* and the *fronto-sphenoidal sutures.*

What points does the superior internal angle present?

The suture between the lacrimal, ethmoid, and frontal bones; between the junction of the two latter bones the *anterior ethmoidal foramen*[2] for the anterior ethmoidal vessels and nasal nerve, and the *posterior ethmoidal foramen*[17] for the posterior ethmoidal vessels.

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The *spheno-maxillary fissure*[26] transmitting the infra-orbital vessels and superior maxillary nerve, the ascending branches from the spheno-palatine ganglion, and the orbital branch of the superior maxillary nerve.

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By a *suture*, the union of the lacrimal and os planum of the ethmoid with the superior maxillary and palate bones.

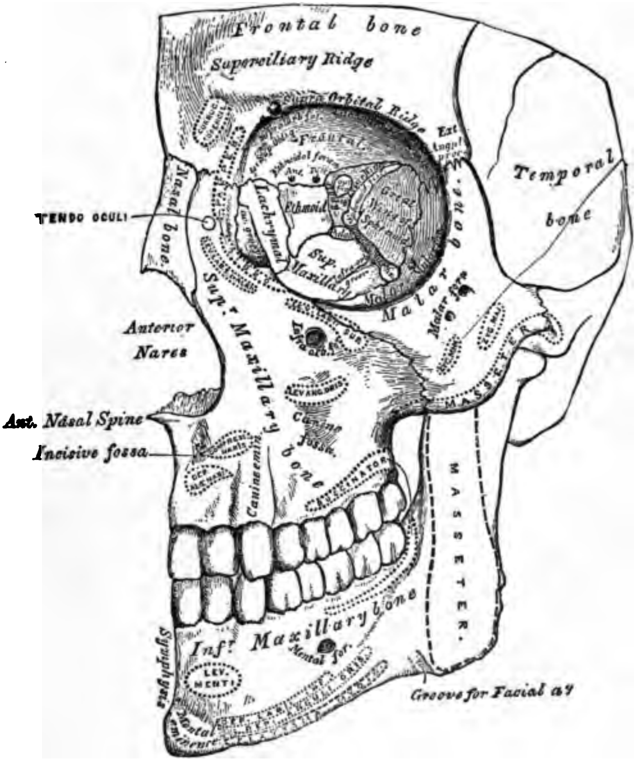


FIG. 33.—Anterior region of the skull (Gray).

What foramen does the orbital margin present?

The *supra-orbital*[3] at the junction of the inner and middle thirds, transmitting the supra-orbital artery, veins, and nerve.

Give the boundaries and the foramina of the middle fossa.

In front it is bounded by the posterior margins of the lesser wings of the sphenoid, the anterior clinoid processes, and the anterior margin of the optic groove; behind, by the upper borders of the petrous portions of the temporal bones and dorsum sellæ; externally by the squamous plates of the temporals and anterior inferior angles of the parietals. The *foramina* are on each side, the *optic* for the optic nerve and the ophthalmic artery. The *sphenoidal fissure* transmits the third, fourth, three branches of the ophthalmic division of the fifth and sixth cranial nerves, and filaments of the sympathetic, the ophthalmic veins, branches of the lacrimal and middle meningeal arteries with a process of the dura mater; immediately behind this, the *foramen rotundum*, for the superior maxillary division of the fifth cranial nerve; more posteriorly, the *foramen ovale*, for the inferior maxillary division of the fifth nerve, the small meningeal artery, and the small petrosal nerve; between the two, internally, the *foramen Vesalii* (often absent), for a small vein; piercing the posterior inferior angle of the greater sphenoidal wing, the *foramen spinosum*, for the middle meningeal artery, meningeal veins, nervus spinosus, a recurrent branch from the inferior maxillary nerve, and the sympathetic branches from the cavernous plexus; on the inner side of the oval foramen the *foramen lacerum* (*medium*) (filled in below by a plate of cartilage in the fresh state), for the internal carotid artery, carotid sympathetic plexus, Vidian nerve, and a small meningeal branch from the ascending pharyngeal artery; on the anterior surface of the petrous portion of the temporal is seen the *eminence* caused by the superior semicircular canal, *eminentia arcuata;* outside this the roof of the middle ear, *tegmen tympani;* the groove leading to the *hiatus Fallopii;* a smaller groove and *foramen* for the small superficial petrosal nerve; a *depression* for the Gasserian ganglion; and the *orifice* of the carotid canal.

Describe the posterior fossa.

It is deeply concave and formed by the occipital, petrous, and mastoid portions of the temporal, the posterior inferior angle of the parietal, and part of the body of the sphenoid. It presents the *meatus auditorius internus* for the facial and auditory nerves and the auditory artery; the *aquæductus vesti-*

buli for a small artery and vein; the *subarcuate fossa;* the *foramen lacerum posterius* transmitting the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, the inferior petrosal and lateral sinuses, and the meningeal branches of the ascending pharyngeal and occipital arteries; the *mastoid foramen* for a vein and artery; the *posterior condyloid foramen* (inconstant) for a vein; the *anterior condyloid foramen* for the hypoglossal nerve, and a meningeal branch from the ascending pharyngeal artery: and in the floor of the fossa in the median line is the *foramen magnum*, accommodating the medulla oblongata and membranes, the spinal accessory nerves, and the vertebral arteries.

What additional foramina or openings are found at either side of the base of the cranium (Fig. 31)?

The *orifice of the Eustachian tube*, admitting air to the middle ear. The *canal for the tensor tympani muscle* above the former, separated from it by the *septum tubæ*, the posterior end of which is the *processus cochleariformis.* The *posterior orifice of the Vidian canal*, for the Vidian nerve and vessels. *Glaserian fissure* for the processus gracilis of the malleus, and the tympanic branch of the internal maxillary artery. The *orifice of the canal of Huguier*, transmitting the chorda tympani nerve. The *canal for Jacobson's nerve*, the tympanic branch of the glosso-pharyngeal. The *aquæductus cochleæ*, for a small artery and vein running to and from the cochlea. The *canal for Arnold's nerve*, the auricular branch of the pneumogastric. The *auricular fissure*, for the exit of Arnold's nerve. The *stylo-mastoid foramen*, for the exit of the facial nerve and the entrance of the stylo-mastoid artery.

The *anterior* and the *posterior* foramina of the palatal region have already been sufficiently described, and this region does not properly belong to the *base of the cranium;* while those opening externally at the *base* and upon the *face* have been described sufficiently under the temporal bone and the superior and inferior maxillary bones.

The Orbital Cavities.

Describe them (Figs. 32 and 33).

They are two quadrilateral pyramidal cavities, with bases outward, their long axes directed from the front inward and

What parts are common to all vertebræ?

A *body*[1]; posteriorly on each side a *pedicle*[2], supporting two *laminæ*[3], which, joining behind, form the *neural arch* and enclose the *spinal foramen*[4]. The arch supports seven processes, one *spinous*[5] where the laminæ join, two *transverse*[6], and four *articular*[7].

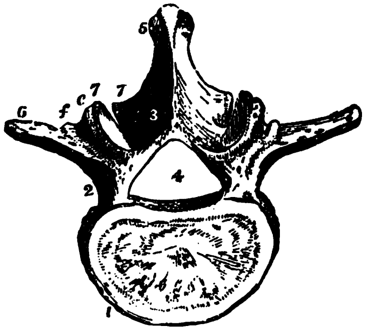


FIG. 35.—A type-vertebra (Leidy).

Describe a vertebral body.

It is composed of cancellous bone, with a thin, compact layer externally; its sides are concave from above downward, while its *upper surface* is in the *cervical* region, concave laterally, forming a lip at either side, while the *lower surface* is convex from side to side and concave from before backward, forming an anterior lip; in the *thoracic* region it is flat above and below; and in the *lumbar region* flattened, or slightly concave above and below. Articular facets and demi-facets for the heads of the ribs mark the *thoracic* bodies, neither the lumbar nor the cervical bodies having these.

Describe the pedicles.

They project backward in all but the cervical vertebræ, where they are directed obliquely outward. They present *vertebral notches* above and below (deepest *above* in the cervical vertebræ; *below* in the thoracic and lumbar spine), forming, when articulated, *intervertebral foramina* for the exit of the spinal nerves and the entrance of vessels.

What are the laminæ?

Two broad plates closing in the spinal foramen, roughened at their upper margins and at the inferior part of their anterior surfaces for the ligamenta subflava.

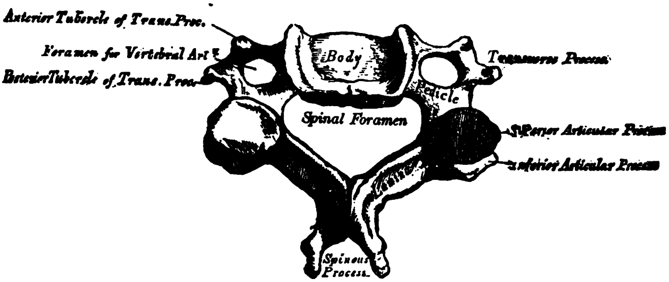

Anterior Tubercle of Trans. Proc.
Foramen for Vertebral Art.
Posterior Tubercle of Trans. Proc.
Body
Transverse Process
Pedicle
Spinal Foramen
Superior Articular Process
Inferior Articular Process
Spinous Process

FIG. 36.—Cervical vertebra (Gray).

Describe the transverse processes.

They are bifid in the cervical and perforated by the vertebral foramen for the vertebral vessels and plexus of nerves; thick and strong, with articular facets in the thoracic; long and slender in the lumbar; they spring from the junction of the pedicle and lamina, and also from the side of the body in the *cervical* region.

Describe the articular processes.

Two are superior and two inferior, projecting from the junction of the laminæ and pedicles. The upper pair look *backward* and *upward* in the cervical region; *backward* and *outward* in the thoracic; *backward* and *inward* slightly in the lumbar; the lower pair are exactly the reverse of the upper in each region.

Describe the spinous processes.

Bifid, short, and horizontal in the cervical; long, triangular, and directed obliquely downward in the thoracic; and thick, broad, and quadrilateral in the lumbar.

Describe the spinal foramen.

It is largest and triangular in the cervical, smallest and round in the thoracic, medium and triangular in the lumbar.

Name the peculiar vertebræ of each region, and describe them.

The first cervical, or atlas (Fig. 37); the second cervical, or axis; the seventh cervical, or vertebra prominens; the first, tenth, eleventh, and twelfth thoracic, and the fifth lumbar.

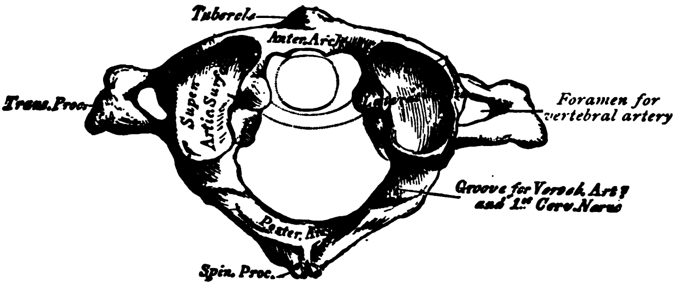


FIG. 37.—First cervical vertebra or atlas (Gray).

The *atlas* supports the head, and is formed of two *lateral masses* joined by an *anterior* and a *posterior arch;* the former presents a *facet* posteriorly for the odontoid process. Upon the upper surface of each lateral mass is an *articular facet*

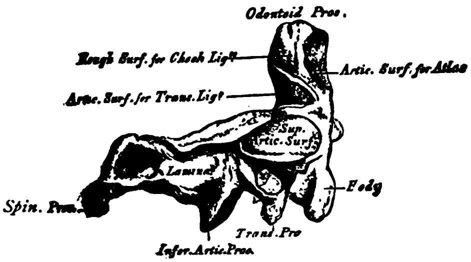


FIG. 38.—Second cervical vertebra or axis (Gray).

looking upward, inward, and backward for the occipital condyles, while the *inferior facet* looks downward and slightly inward; a small tubercle represents the spinous process. *Development* is by one center for the anterior arch (first year); one for each lateral mass (seventh fetal week).

The *axis* (Fig. 38) has surmounting the body the *odontoid process*, with a *facet* in front for articulation with the atlas, another behind for the transverse ligament, with a *roughened apex* to which are attached the check ligaments; on each side of the odontoid, facing upward and outward, are the superior articular processes. *Development* is like other vertebræ, except three additional centers for the odontoid, two appearing at the sixth fetal month, making six.

The *vertebra prominens* (Fig. 39) is so called because of its long spinous process, to which is attached the ligamentum nuchæ. *Development* is like other vertebræ, except one additional center for the anterior part of the transverse process.

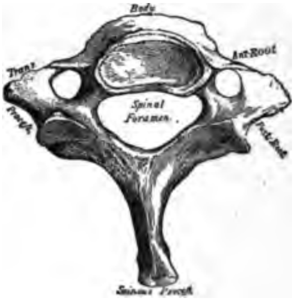


FIG. 39.—Seventh cervical vertebra, or vertebra prominens (Gray).

The peculiar thoracic vertebræ (Fig. 41).

The first has an *entire facet* and a *demi-facet* on the body; the ninth usually has no peculiarity; the tenth has a *demi-facet* on the pedicle and *one facet* on the transverse process; the eleventh and twelfth have *one facet* on the pedicle, none on the transverse processes, the latter also closely resembling those of a lumbar vertebra.

The *fifth lumbar* has a markedly wedge-shaped body, with the base forward.

How are the ordinary vertebræ developed?

By two centers for the body and one for each lamina (sixth to eighth fetal week); at sixteen years one center for the tip of each transverse, and two for the spinous process; and at twenty-one years a plate upon the upper and the lower surfaces of the body, making ten in all; the lumbar vertebræ have two addi-

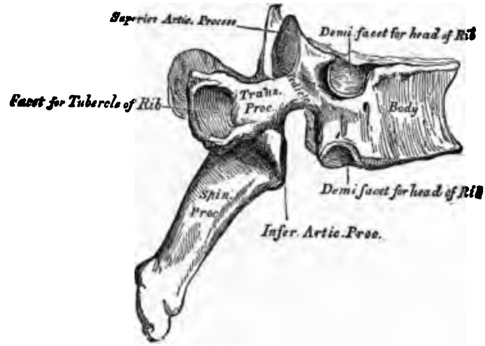
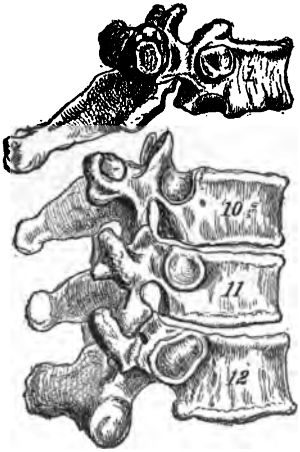

Superior Artic. Process
Demi-facet for head of Rib
Facet for Tubercle of Rib
Trans. Proc.
Pedicle
Body
Spin. Proc.
Demi-facet for head of Rib
Infer. Artic. Proc.

FIG. 40.—A thoracic vertebra (Gray).

tional centers tipping the superior articular processes; coössification at thirty years.



An entire facet above.
A demi-facet below.

—*A demi-facet above.*

An entire facet.
No facet on trans. proc., which is rudimentary.

An entire facet.
No facet on trans. proc.

Infer. artic. proc., convex and turned outward.

FIG. 41.—Peculiar thoracic vertebræ.

Describe the sacrum.

It is composed of five consolidated vertebræ, is of triangular form with broad base and blunted apex and lateral expanded masses or alæ; its anterior surface is concave, its posterior convex, and with the coccyx it forms the posterior wall of the true pelvis. Its anterior surface (Fig. 43) is marked by four transverse *ridges*, indicating the lines of junction of the segments; eight *anterior sacral foramina* with broad shallow *grooves* for the anterior sacral nerves open on this surface;

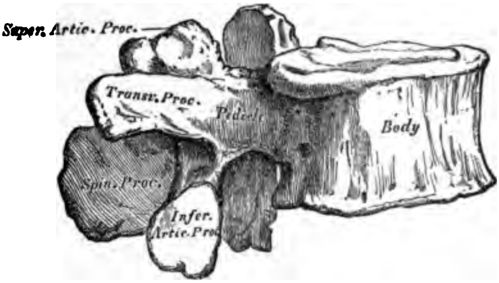


FIG. 42.—Lumbar vertebra (Gray).

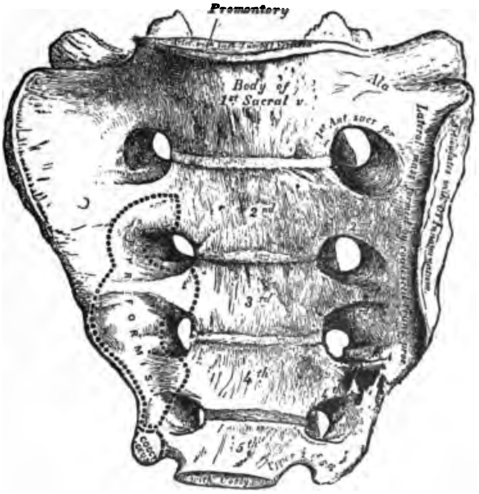


FIG. 43.—Sacrum, anterior surface (Gray).

the point of junction with the last lumbar vertebra forms the *promontory* (sacro-vertebral angle); and upon each side are the *alæ*—the expanded portions of the bone. Posteriorly (Fig. 44) are three or four median tubercles (rudimentary spinous processes); externally are the laminæ, those of the fifth and sometimes the fourth being deficient; outside these is a row of rudimentary articular processes. On each side of the spine is a broad *sacral groove*, lodging the origin of the erector spinæ muscle; externally are the four *posterior sacral foramina* on each side; at the posterior inferior portion of the bone are the two *cornua*—articulating surfaces for the coccyx; each lateral surface has on its anterior upper part an *auricular surface* for articulation with the ilium; on each side of the apex below is a deep *notch*, for the fifth sacral nerve; the *base* resembles the upper surface of a lumbar vertebra, with the last of which it articulates; the *apex*, directed downward and forward, has an oval concave articular surface for the coccyx; the *sacral canal* runs the whole length of the bone, triangular above, small and flattened below, and deficient in its posterior

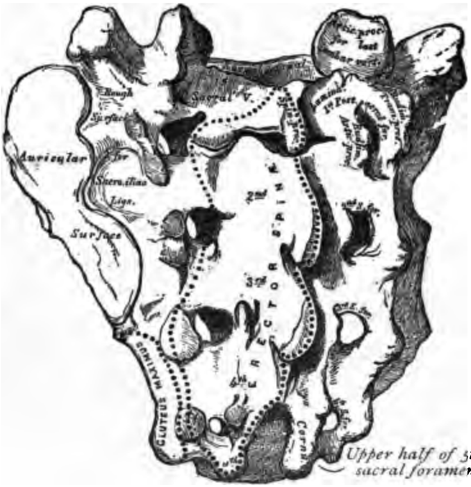


FIG. 44.—Sacrum, posterior surface (Gray).

wall at the lower part; it lodges the sacral nerves, and into it open the anterior and posterior sacral foramina.

What centers of ossification has the sacrum?

Thirty-five or forty, appearing from the eighth fetal week to the twentieth year, coössification being complete from the twenty-fifth to the thirtieth year. The bodies have each three or four centers: each lamina one center; the lateral masses three centers each; the lateral surfaces two each.

Give the muscular attachments.

The pyriformis, coccygeus, and iliacus in front; the gluteus maximus, latissimus dorsi, multifidus spinæ, erector spinæ, and sometimes the extensor coccygis behind—seven pairs.

Describe the coccyx (Fig. 45).

It is usually composed of four rudimentary vertebræ, more or less coössified; it forms a triangular bone whose *base*[1] articulates with the sacral apex. The first piece presents two *cornua*[2], projecting upward from either side of the base for articulation with the sacral cornua, their junctions completing the fifth sacral foramina for the posterior branches of the fifth nerves. The *apex*[6] is rounded and occasionally bifid or turned to one side; rudimentary bodies, transverse and articular processes may be seen on the first two segments.

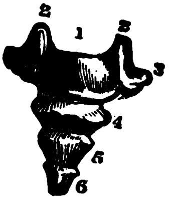


FIG. 45.—Coccyx.

Describe its development.

From four centers: one for each segment, the first piece commencing at birth; second, five to ten years; third, ten to fifteen years; fourth, fifteen to twenty years; coössification varies as to time and manner.

Give the muscular attachments.

Laterally the coccygeus; behind the gluteus maximus and extensor coccygeus (inconstant); apex, sphincter ani; in front, the levator ani.

The Hyoid Bone.

Describe this bone and its development (Fig. 46).

It consists of a body and two *greater* and two *lesser cornua;* the *greater cornua* project backward from the lateral surfaces of the body, and have attached to their tubercular ends the thyro-hyoid ligaments; the *lesser cornua*, attached to the junction between the body and the greater cornua, give attachment by their apices to the stylo-hyoid ligaments; it is *developed* by five centers: one for the body, one for each greater horn toward the end of fetal life, and one for each lesser horn some months after birth.

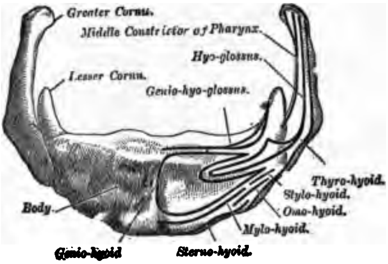


FIG. 46.—Hyoid bone, anterior surface (Gray).

Give the muscular attachments.

The sterno-hyoid, thyro-hyoid, omo-hyoid, digastric, stylo-hyoid, mylo-hyoid, genio-hyoid, genio-hyo-glossus, chondro-glossus, hyo-glossus, middle pharyngeal constrictor, and sometimes the lingualis.

The Thorax.

Give its structure, form, and boundaries.

It is conical in form, and its osseo-cartilaginous framework is formed by the thoracic vertebral bodies behind, the ribs laterally, and the costal cartilages and sternum in front; its base is formed by the diaphragm. Through its apex pass the great cervical vessels, the pneumogastric, phrenic, and sympathetic nerves, the trachea, esophagus, thoracic duct, and apices of the lungs covered by pleura.

FIG. 47.

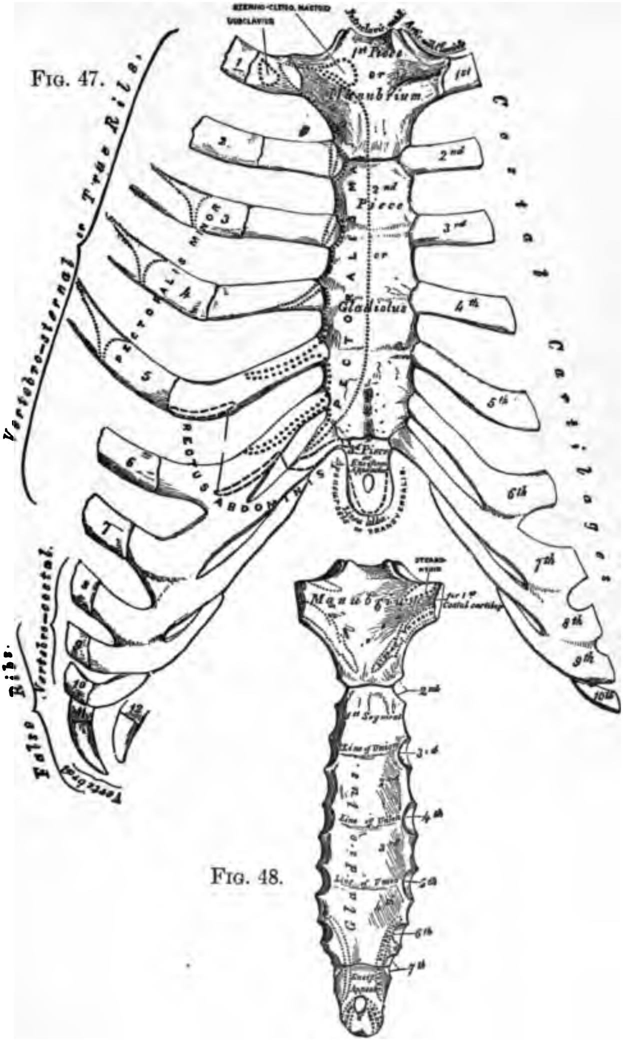


FIG. 48.

FIG. 47.—Sternum and costal cartilages. FIG. 48.—Posterior surface of sternum. (Gray.)

What are the most important structures this cavity contains?

The trachea, primitive bronchi and lungs, the heart, aorta and its primary branches, the internal mammary vessels, the venæ cavæ, bronchial and azygos veins, the pneumogastric, phrenic, and splanchnic nerves, the esophagus, thoracic duct, lymphatic vessels and glands, thymus gland or its remains.

The Sternum.

Describe it (Figs. 47 and 48).

The breast-bone consists of three segments, viz. the manubrium (handle), the gladiolus (sword), and the ensiform (xiphoid) cartilage. Upon the upper border of the *manubrium* is the *interclavicular notch*, upon either side of which is the *facet* for the clavicle; lower, another for the first rib; below, a *demi-facet* for the second rib.

The *gladiolus* has a *demi-facet* above for the second rib, another below for the seventh; and between, *facets* for the third fourth, fifth, and sixth ribs.

The *ensiform cartilage* has a *demi-facet* above for the cartilage of the seventh rib.

How is this bone developed?

By six centers: one for the manubrium, four for the gladiolus, one for the ensiform cartilage (fifth fetal month to eighteenth year); the three pieces rarely coössify.

What muscles are attached to this bone?

Above, the sterno-cleido-mastoid, the sterno-hyoid, and the sterno-thyroid; below, the rectus abdominis, the external and internal oblique, the transversalis, and the diaphragm; in front, the pectoralis major; behind, the triangularis sterni.

The Ribs.

What is their number, and how are they divided?

Twelve on each side, seven of which are *true*, or those articulating with the sternum by a separate cartilage; five *false*, three of which indirectly articulate through the medium of the seventh cartilage; while the two lowest, having their anterior extremities free, are called *floating ribs.*

Of what parts does a rib consist?

A head, neck, shaft, angle, and tuberosity, except the eleventh and twelfth ribs.

Describe these parts (Fig. 49).

The *head*[1] (except the first, eleventh, and twelfth ribs, which each have only one facet) is divided into two facets by a ridge for the interarticular ligament. The neck[2] is flattened, *roughened* upon its upper border for the anterior, and upon its posterior surface for the middle costo-transverse ligaments; in front it is smooth. The *tuberosity*[3] (absent in the eleventh and twelfth), placed at the base of the neck, presents a facet for the transverse process of the next lower vertebra, and a *rough surface* for the posterior costo-transverse ligament. The *shaft*[5] is twisted on its long axis (except the first and second), externally convex, its upper border rounded, its lower *grooved*[4] for the intercostal vessels and nerve, and presents at its anterior extremity an *oval depression*[6] for the costal cartilage. The *angle*, at a variable distance in front of the tuberosity, is indicated by a *rough line.*

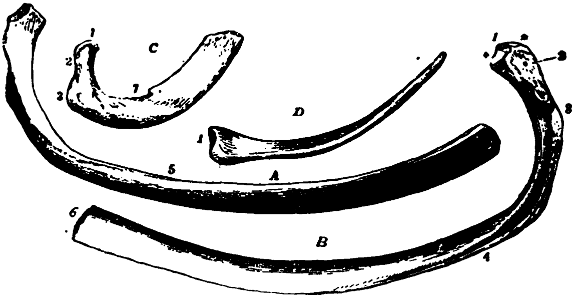


FIG. 49.—*A* and *B*, typical ribs; *C*, first rib; *D*, twelfth rib.

How are the ribs developed?

By three centers (except the eleventh and twelfth, two centers), one each for the head, shaft, and tuberosity (for the shaft, sixth fetal week); for the head and tuberosity (sixteenth to the twentieth year); coössifies at the twenty-fifth year.

Describe the peculiar ribs.

They are the first, second, eleventh, and twelfth ribs (Figs. 49 and 50).

First rib[6], broad, short, flat, one facet on the head, angle absent; on the upper surface two parallel grooves, the anterior for the subclavian vein, the posterior for the artery, and between them a *tubercle*[7] (Lisfranc's) for the anterior scalene muscle, a *guide to the subclavian artery.*

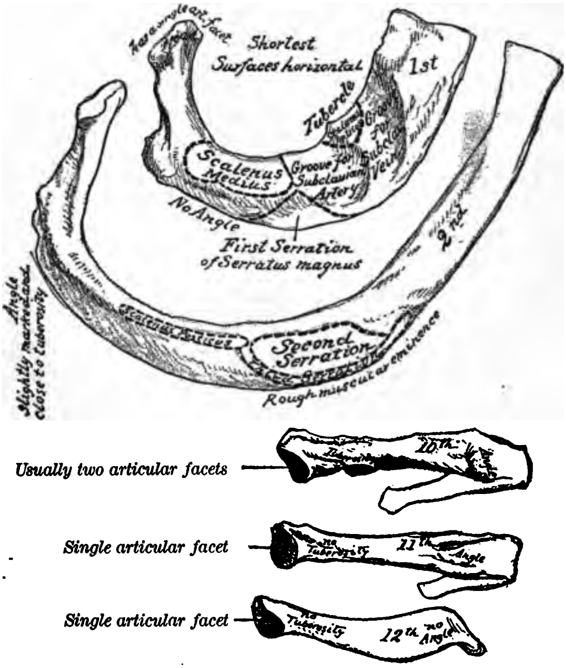


FIG. 50.—Peculiar ribs.

Second rib, also flattened, the tuberosity and angle nearly coincide, and presents near its middle a *rough eminence* for the attachment of the second and third digitations of the serratus magnus and for the scalenus posticus.

Tenth rib, usually two facets on the head, hence not peculiar.

Eleventh rib, one facet on the head; no tuberosity, no neck, slight angle.

Twelfth rib[d], one facet on the head; neither neck, angle, nor tuberosity.

Describe the costal cartilages.

The costal cartilages (Fig. 47) prolong the ribs to the sternum and greatly increase the elasticity of the chest-wall; they gain in length to the seventh, and then become shorter; their breadth decreases from above down; their directions vary: the first descends, the second is horizontal, the third ascends, and the others (except the last two) descend in the line of the rib for a short distance and then ascend. Each presents two surfaces, two borders, and two extremities; the *anterior surfaces* are convex and give attachment in part to the thoracic and abdominal muscles; the *posterior surfaces* are concave, giving attachment to the diaphragm and triangularis sterni; the *borders* give attachment to the intercostal muscles and fasciæ; the *outer ends* are continued into the osseous tissue of the ribs; *internally*, the cartilages of the true ribs unite with the sternum (see page 80); those of the first three false ribs (eighth, ninth, and tenth) become slender and pointed, and unite with the one above; the eleventh and twelfth are pointed and free. The sixth, seventh, and eighth (sometimes the fifth and ninth) have a series of interchondral articulations by means of a broad cartilaginous band. All are prone to ossify in old age.

The Pelvic Bones.

What are they?

The ossa innominata, the sacrum, and the coccyx.

Describe the innominate bone (Figs. 51 and 52).

It is formed by the union, about puberty, of three bones, the ilium, ischium, and pubes (Fig. 51). At their point of junction is the *acetabulum* (cotyloid cavity) for the head of the femur—the pubes forming one-sixth, the ilium three-sixths, and the ischium two-sixths. A rough central depression at the bottom of the acetabulum lodges a vascular mass of fat covered with synovial membrane, while the anterior lower margin is interrupted by the *cotyloid notch*, bridged across by the transverse ligament, beneath which pass the nutrient vessels and ligamentum teres, which latter arises from either side of the notch externally; the whole margin has attached to it the

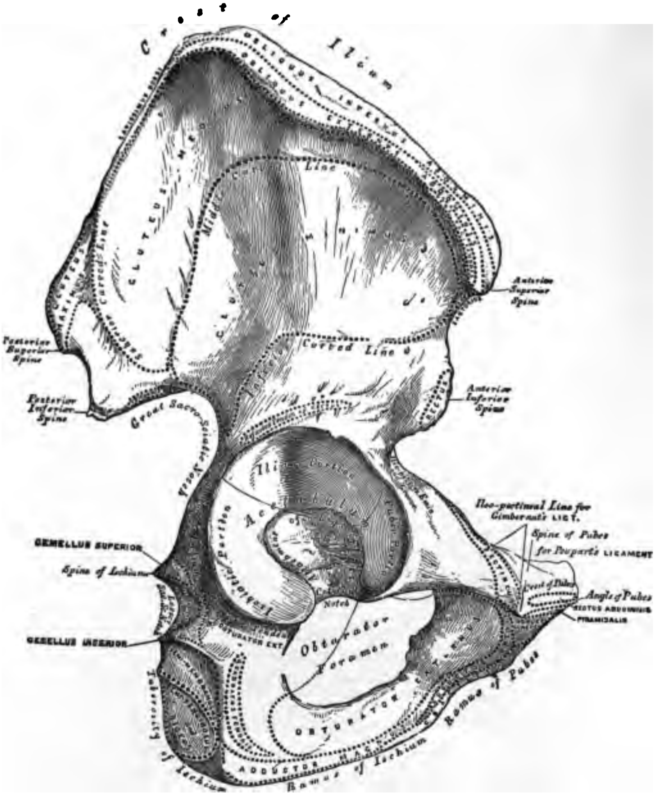


FIG. 51.—Right os innominatum, external surface (Gray).

cotyloid ligament. Between the pubes and the ischium, on the anterior surface, is the *obturator foramen* (thyroid), closed by the membrane of the same name, except above externally, where the obturator vessels and nerve escape; the foramen is a large ovoidal opening in the male, a smaller and triangular one in the female.

Describe the ilium.

This is the upper expanded portion of the bone (Fig. 51), presenting along its upper border the *crest* with its outer and inner lips, terminating in front by the *anterior superior spinous process*, giving origin to Poupart's ligament, the sartorius and tensor fasciæ femoris muscles, and behind by the *posterior superior spinous process*, to which are attached part of the erector spinæ muscle and the oblique band of the sacro-iliac ligament. Below both the anterior and posterior spines is a process called, respectively, the *anterior* (for the straight tendon of the rectus femoris muscle) and *posterior inferior spinous* (for the great sacro-sciatic ligament); by these projections a *notch* is formed in front and behind, the former giving partial origin to the sartorius muscle and transmitting the external cutaneous nerve. Between the posterior inferior spine and the spine of the ischium is situated the *greater sacro-sciatic notch*, giving exit to the pyriformis muscle, the greater and lesser sciatic, superior and inferior gluteal and pudic nerves, also one to the obturator internus muscle, and the sciatic, gluteal, and pudic vessels. About two inches from the posterior superior spine, passing downward and outward from the crest, is the *superior gluteal line*, from the surface back of which arise the gluteus maximus muscle and a few fibers of the pyriformis; about an inch behind the anterior superior spine, passing from the crest downward and backward to the upper part of the great sacro-sciatic notch, is the *middle gluteal line*, the gluteus medius arising from the space between these two lines; passing downward and backward, from the upper part of the anterior inferior spine to the front of the sacro-sciatic notch, is the *inferior gluteal line*, between which and the middle arises the gluteus minimus. Above the acetabulum is a *groove* for the reflected tendon of the rectus femoris muscle. The *inner surface* presents (Fig. 52) in front the *iliac fossa* for the iliacus muscle and a broad groove for the psoas-iliacus tendon; posteriorly is seen—1, a smooth surface below the ilio-pectineal line in the true pelvic cavity; 2, an *auricular surface* for the sacrum; 3, a rough surface for the sacro-iliac ligaments; 4, a rough surface for the muscles of the back.

Describe the ischium.

It consists of a *body*, *tuberosity*, and *ramus*, and forms the lowest part of the innominate bone. The external surface of the *body* forms two-sixths of the acetabulum; below this is a *groove* for the obturator externus tendon; its inner surface forms the lateral boundary of the true pelvis; from the posterior border, below the center, projects the *spine of the ischium*, above and below which are the *greater* and *lesser sacro-sciatic notches*, the latter giving egress to the obturator internus muscle and ingress to its nerve and to the pudic vessels and nerve. The lowest portion presents a *tuberosity*, with an outer and an

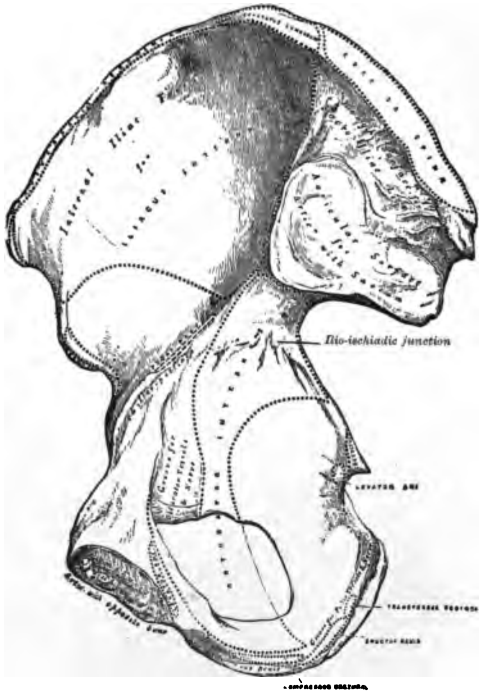


FIG. 52.—Right os innominatum, internal surface (Gray).

inner lip—to the latter being attached the greater sacro-sciatic ligament; to the outer is attached the quadratus femoris and adductor magnus muscles. Passing upward and inward from the tuberosity to join the ramus of the pubes, and bounding the obturator foramen in front, is the thin, flattened *ascending ramus.*

Describe the pubes.

This bone (also called pectineal) consists of a *body*, a *horizontal* and a *descending ramus.* The outer end of the horizontal ramus forms one-sixth of the acetabulum; above, a rough *ilio-pectineal eminence* indicates the point of junction with the ilium; the inner end is the oval *symphysis* with eight or nine *ridges* for attachment of the fibro-cartilage; the upper triangular surface presents posteriorly the pectineal portion of the *ilio-pectineal line;* the anterior surface presents the *crest*, ending externally in the *pubic spine* giving attachment to Poupart's ligament, internally in the *angle;* below is a *groove* for the

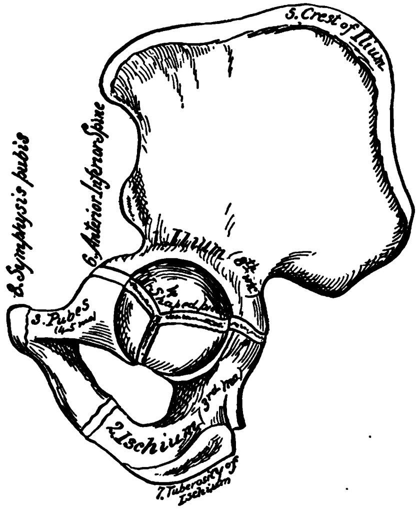


FIG. 53.—Plan of the development of the os innominatum.

obturator vessels and nerve; the *descending ramus*, thin and flat, joins that of the ischium, completing the anterior boundary of the obturator foramen.

How are these bones developed?

By three primary centers (Fig. 53), one for each bone (from the eighth fetal week); and five secondary centers: one for the crest, one for the tuberosity, one for the anterior inferior spine, one for the symphysis, and one Y-shaped, joining the three pieces forming the acetabulum, appearing about puberty; bone coössifies completely about the twenty-fifth year. (For order of junction, see Gray.)

What muscular attachments has the innominate bone?

Those of the abdomen, some of the thigh, those of the perineum and pelvic floor.

The Pelvis.

Describe the pelvis.

Formed by the two innominate bones, the sacrum and the coccyx, all above the ilio-pectineal lines is called the *false pelvis*, consisting of the two *iliac fossæ;* all below, the *true pelvis.*

Describe the true pelvis.

Its *brim*, or inlet, somewhat heart-shaped, is formed by the linea ilio-pectinea at the sides, completed in front by the spine and crest of the pubes, behind by the anterior margin of the base of the sacrum and promontory of the sacrum. Its aver-

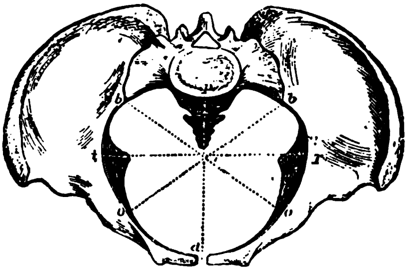


FIG. 54.—Diameters of the pelvis.

age diameters in the female are, antero-posterior^{d}, four inches; the oblique^{ob}, four and one-half inches; transverse^{tr}, five inches; its long axis, if extended, would pass from the middle of the coccyx to the umbilicus; in the male these measurements are diminished by at least one-half inch.

Describe the cavity.

This is bounded in front by the symphysis pubis, behind by the concavity of the sacrum and coccyx, on either side by the broad, smooth inner surface of the ischium and by the lower part of the ilium, forming a curved canal wider in the middle than at its outlets, measuring in depth of the symphysis one and one-half inches, three and one-half inches in the middle axial line, and four and one-half inches posteriorly, perhaps as much as five and one-half inches in males.

Describe the lower circumference of the pelvis.

This is called the *outlet*, is bounded on each side by the tuberosity of the ischium, the pubic arch in front and tip of the coccyx behind. Its diameters, antero-posterior, oblique, and transverse, measure respectively five, four and one-half, and four inches, being the reverse of the diameters of the inlet, explaining the rotation of the fetal head; in the male the diameters average three and one-half inches.

What are the chief differences between the male and the female pelvis?

The strength of the bones, distinctness of the muscular impressions, the depth and narrowness of the cavity, and large obturator foramina mark the *male pelvis;* the lighter bones, broader iliac fossæ, the less-curved sacrum, the wider pubic arch, and the universally greater diameters distinguish the *female pelvis.*

BONES OF THE UPPER EXTREMITY.

Name the bones.

The clavicle, scapula, humerus, radius, ulna, scaphoid, semilunar, cuneiform, pisiform, trapezium, trapezoid, os magnum, unciform, five metacarpal, and fourteen phalangeal bones.

Describe the clavicle.

It is a long bone, curved like the italic letter *f*, its outer third flattened from above downward, and concave anteriorly; the inner two-thirds is cylindrical and convex anteriorly; it extends almost horizontally between the sternum and scapula, the two extremities being respectively termed the *sternal* and the *acromial.*

Describe the chief points presented by the clavicle, commencing at the outer extremity.

The upper surface (Fig. 55) has *impressions*, that in front for the deltoid, that behind for the trapezius; at the outer end is a *facet* articulating with the acromial process of the scapula; at the posterior border, beneath, is the *conoid tubercle* (Fig. 56), just above the coracoid process of the scapula, for the conoid ligament; extending from the tubercle, forward and outward, nearly to the outer end of the anterior border is the *oblique line* for the trapezoid ligament; occasionally at the center of the anterior border of the outer third is the *deltoid tubercle.* The under surface of the middle portion presents the *subclavian groove* for the same named muscle—either here or on the posterior surface appears the *medullary foramen* directed outward;

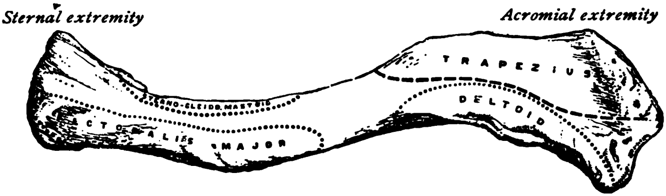


FIG. 55.—Left clavicle, superior surface (Gray).

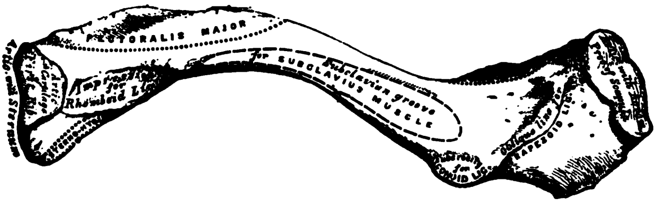

PECTORALIS MAJOR
Artic. with Sternum
Artic. with Cartilage of First Rib
Impression for Rhomboid Lig.
STERNO-MASTOID
for SUBCLAVIUS MUSCLE
Subclavian groove
Tuberosity for CONOID LIG.
Oblique line for TRAPEZOID LIG.
Artic. with Scapula

FIG. 56.—Left clavicle, inferior surface (Gray).

the inner third of the superior border bears an *impression* for the sterno-mastoid muscle (Fig. 55), while the inner half of the anterior margin has another *impression* for the pectoralis major muscle. Beneath the posterior border of the sternal end is the *rhomboid impression*, for the rhomboid or chondro-clavicular ligament. The *sternal end* is triangular in form, its inner surface for articulation with the sternum, this surface being continuous with a facet beneath, for articulation with the first costal cartilage.

Give its development.

By two centers: one for the shaft earliest in the body (thirtieth day); one for the sternal end (eighteenth to twentieth year); uniting about the twenty-fifth year.

Give the muscular attachments.

The sterno-cleido-mastoid, trapezius, pectoralis major, deltoid, subclavius, sterno-hyoid, and usually the sterno-thyroid; six or seven in all.

Describe the scapula.

The shoulder-blade, a large, flat, triangular bone, extends from the second to the seventh rib or seventh space on the back and side of the thorax, its posterior margin lying nearly parallel to and one inch from the spinous processes of the vertebræ.

The *venter* (anterior surface) or *subscapular fossa* is concave, presents some transversely oblique ridges (Fig. 57) for the tendinous insertions of the subscapular muscle, and a *marginal surface* along the inner border—triangular above and below, linear between—for the serratus magnus muscle. The *subscapular angle* is the transverse depression at its upper part where the fossa is deepest.

The *dorsum* (posterior surface) (Fig. 58) is divided by a prominent bony ridge, the *spine*, affording attachment to the deltoid and trapezius muscles and ending in the *acromion process*, into the *supra-* and *infraspinous fossæ*, for the origin of similarly named muscles; in the latter is a *nutrient foramen.* The lower fossa presents a *marginal surface*, divided by an *oblique line* at the junction of the lower and middle thirds, into two surfaces, the lower for the teres major, the upper for the teres minor muscles; about the junction of the middle and upper thirds of this border is a *groove* for the dorsalis scapulæ vessels. The spine internally presents a *triangular surface*, over which plays the ascending part of the trapezius muscle.

The *acromion process* (summit of the shoulder) is a triangular flattened process, curving outward, forward, and upward, to overhang the glenoid fossa; giving attachment along its outer margin to the deltoid; its inner margin, the trapezius; by its *apex*, to the coraco-acromial ligament; and having on its inner margin, behind the apex, an articular *facet* (Fig. 57) for the clavicle.

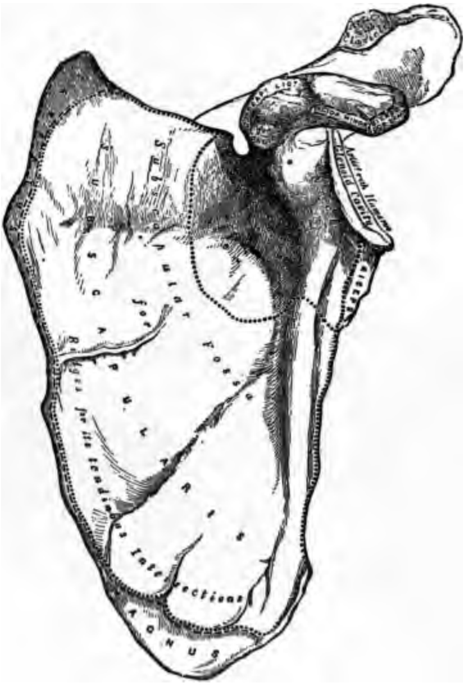


FIG. 57.—Left scapula, anterior surface or venter (Gray).

Describe the coracoid process of the scapula.

The *coracoid process* (Figs. 57, 58) (like a crow's beak) rises by a broad base from the upper part of the neck of the scapula, curving over the inner part of the glenoid cavity. To the anterior margin, near the tip, is attached the pectoralis minor muscle, and from its apex arise the short head of the biceps and the coraco-brachialis muscle. To the inner side of the

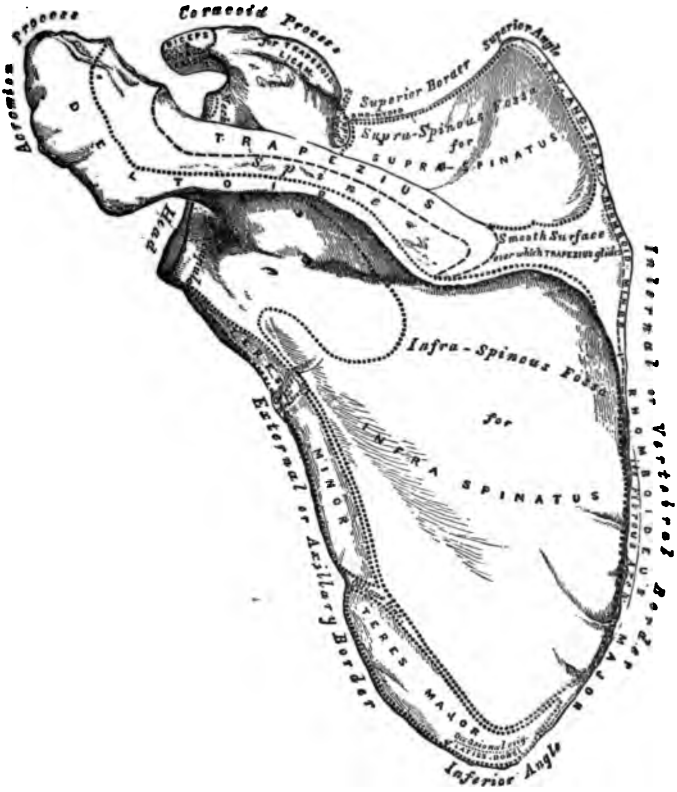


FIG. 58.—Left scapula, posterior surface or dorsum (Gray).

root is a rough *impression* for the conoid ligament, whence runs obliquely forward and outward on its upper surface a *ridge* for the trapezoid ligament. The coraco-acromial ligament is attached externally.

Describe the scapular borders.

The *superior border*—the shortest—presents at the base of the coracoid the *suprascapular notch* (Fig. 58), becoming a foramen when the transverse ligament is in situ, *through* which passes the suprascapular nerve, *above* which passes the suprascapular artery; from the border just internal to the notch arises the omo-hyoid muscle. The *axillary border*—the thickest—presents just below the glenoid fossa a *rough surface* for the long head of the triceps muscle, succeeding which is a longitudinal *groove* for part of the subscapular muscle. The *vertebral border*—the longest—presents an *anterior lip* for the serratus magnus muscle, a *posterior lip* for the supra and infraspinatus muscles, and an *intermediate space* for the levator scapulæ above, for the rhomboideus minor from the edge of the triangular apex of the spine, and for the fibrous arch of the rhomboideus major muscle below.

Give the points of interest connected with the angles.

The *superior angle* (Fig. 57) affords partial attachment to the serratus magnus, to the levator scapulæ, and supraspinatus muscles. The *inferior angle* (Fig. 58) affords attachment to the teres major muscle, part of the serratus magnus, and (often) a few fibers of origin of the latissimus dorsi. The external angle, or head, presents a shallow pyriform *glenoid fossa* (Fig. 57) for the head of the humerus, deepened, in the fresh state, by the glenoid ligament, from the upper part of which and from the *supraglenoid tubercle* the long head of the biceps flexor cubiti arises. The *neck* (Fig. 58) is the slightly depressed surface surrounding the head; the *surgical* neck is well posterior to the head, passing through the suprascapular notch (Fig. 58).

How is this bone developed?

By seven centers: one for the body (second fetal month); two for the coracoid (one at the first year, one at the fifteenth to the seventeenth year); two for the acromion; one for the vertebral border; one for the inferior angle (all these last, fifteenth to seventeenth year); coössification (twenty-second to twenty-fifth year). The acromion may not unite with the spine by bony union, but by a gliding joint with synovial membrane.

Give the muscular attachments.

The subscapular, supra and infraspinatus, deltoid, trapezius, omo-hyoid, serratus magnus, levator scapulæ, rhomboideus minor and major, triceps, teres minor and major, biceps, coraco-brachialis, pectoralis minor, occasionally the latissimus dorsi.

The Arm.

Describe the chief processes and the general characteristics of the humerus.

This, the only *arm* bone, articulates above with the scapula, below with the ulna and radius. The upper extremity, the *head* (Fig. 59), nearly hemispherical, facing upward, inward, and slightly backward, forms with the glenoid fossa of the scapula the shoulder or scapulo-humeral joint. Best marked superiorly is the constriction called the *anatomical neck*, indicating the capsular attachment; external to the head is the *greater tuberosity*, with three facets for the supra- and infraspinatus and the teres minor muscles; in front, directed inward and forward, is the *lesser tuberosity* for the subscapular muscle; commencing between these two projections, and extending for the upper third of the bone, is the *bicipital groove*, passing obliquely downward and inward, lodging the long head of the biceps muscle; into the *anterior lip* of this groove is inserted the pectoralis major muscle, into the *posterior lip* the teres major, and into the floor the latissimus dorsi. The constriction beneath the tuberosities is called the *surgical neck*. The *shaft*, cylindrical above, prismoid and flattened below, presents upon the middle of its outer surface a *roughness* for the deltoid muscle, and below it, winding from behind forward and downward, on the back of the bone (Fig. 60), is the *spiral groove* for the musculo-spiral nerve and superior profunda artery, internal and external to which arise the inner and outer heads of the triceps muscle. At about the center of the inner border of the bone is an *impression* for the coraco-brachialis muscle, just below which is the *medullary canal*, directed downward. The lower half of the anterior border, the lower half of the external and the internal surfaces, and the internal supracondylar ridge give origin to the brachialis anticus. The lower extremity presents an *inner* (very prominent) and an *outer epicondyle*, extending from each of which, upward on the

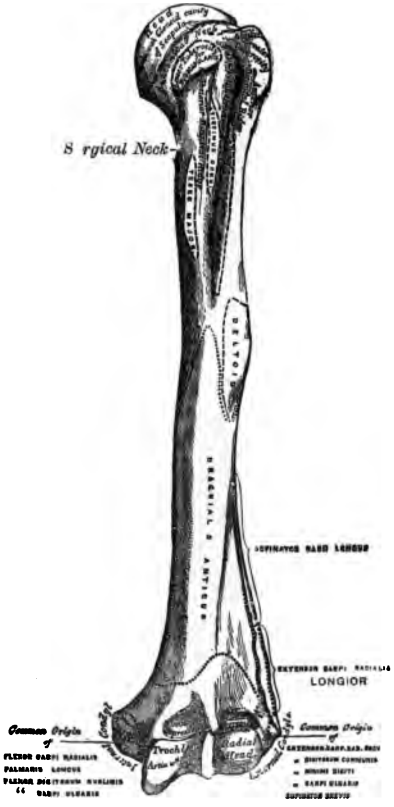


FIG. 59.—Left humerus, anterior view. (Gray.)

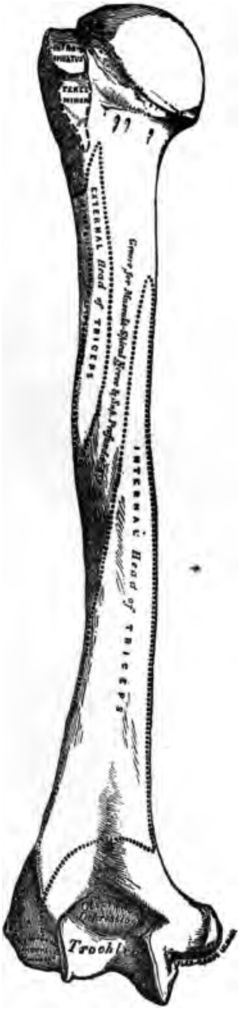


FIG. 60.—Left humerus, posterior view.

shaft, are the *internal* and the *external supracondylar ridges;* from the external ridge and epicondyle arise the external lateral ligament and the *extensor* and *supinator* muscles; from the inner epicondyle and ridge arise the internal lateral ligament and the *flexor* muscles and *round pronator.* Projecting from the lower front portion of the outer condyle is the *radial head* (capitellum), for articulation with the radius; while internal to this, extending from the anterior to the posterior surface of the bone, is the pulley-like *trochlear surface* for the greater sigmoid cavity of the ulna. The *coronoid fossa* in front of the trochlea receives the coronoid process of the ulna during flexion of the forearm, while the *olecranon fossa,* similarly placed behind, accommodates the tip of the olecranon during extension.

How is the humerus developed?

By seven centers: one for the shaft (fifth fetal week); one for the head (first to second year); one (sometimes two) for the tuberosities (second to third year; by the fifth year the centers for the head and the tuberosities have coössified); one for the radial head (second year); one for the internal epicondyle (fifth year); one for the trochlea (twelfth year); one for the external epicondyle (thirteenth to fourteenth year). The lower centers are all coössified with the shaft by the sixteenth or seventeenth year except that for the inner epicondyle, which unites at the eighteenth year, while the head unites at the twentieth year.

Give the muscular attachments.

The supra and infraspinatus, teres minor, subscapularis, pectoralis major, latissimus dorsi, teres major, deltoid, coracobrachialis, brachialis anticus, triceps, subanconeus, pronator teres, flexor carpi ulnaris, palmaris longus, flexor digitorum sublimis, flexor carpi radialis, supinator longus, extensor carpi radialis longior and brevior, extensor communis digitorum, extensor carpi ulnaris, anconeus, supinator brevis, and extensor minimi digiti (sometimes).

The Forearm.

Describe the ulna.

This, the inner forearm bone (Fig. 61), longer than the radius, forms the greater part of the articulation with the

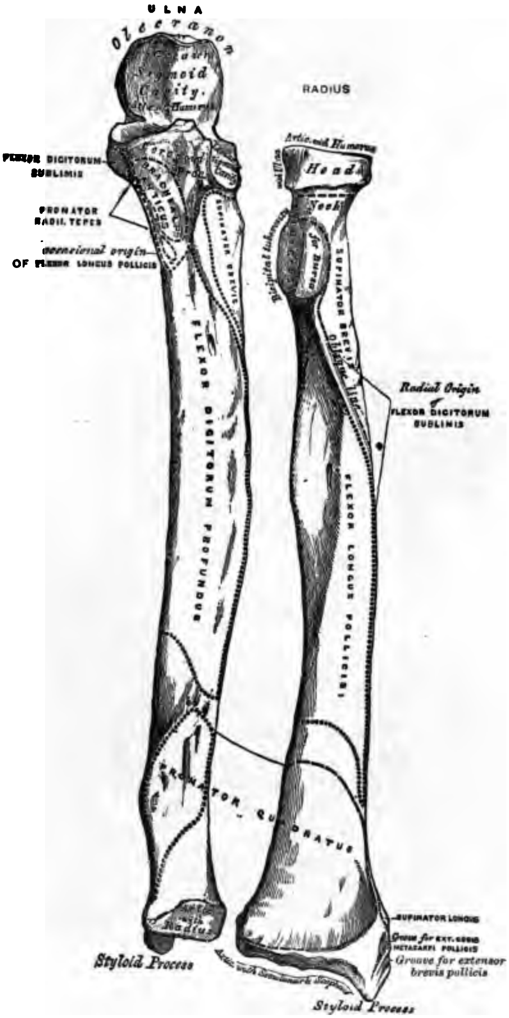


FIG. 61.—Bones of the left forearm, anterior surface (Gray).

humerus, while it is excluded from the wrist-joint by the interarticular fibro-cartilage. Its upper extremity forms the point of the elbow. The *olecranon process* presents upon its anterior part a saddle-shaped articular surface which, with its continuation on the coronoid process, is the *greater sigmoid cavity* for the trochlea of the humerus; continuous with this upon the outer side is the *lesser sigmoid cavity* for the head of the radius; to the superior surface is attached the triceps tendon, and the *apex* is accommodated by the olecranon fossa of the humerus during extension. Projecting forward below the olecranon is the *coronoid process*, fitting into the same named fossa of the humerus during flexion, its upper surface forming part of the greater sigmoid cavity; it presents, where it joins the shaft, a tubercle for the oblique ligament and a *rough impression* for the brachialis anticus muscle above and internally. At the front is a small *eminence* for the flexor sublimis digitorum, whence descends a *ridge* for the pronator teres. The *shaft*, large and prismatic above, smaller and rounded below, has on its *anterior surface* the *medullary foramen*, directed upward, and gives attachment to the flexor profundus digitorum and pronator quadratus muscles; the *internal surface* gives attachment to the flexor profundus; the *posterior surface* (Fig. 62) gives attachment from above downward to the anconeus, supinator brevis, extensor ossis metacarpi pollicis, extensor longus pollicis, and extensor indicis. The *posterior border* gives attachment by a common aponeurosis to the flexor and extensor carpi ulnaris and to the flexor profundus digitorum. The *external sharp border* affords attachment to the interosseous ligament. The lower carpal extremity, or *head*, articulates by its outer surface with the sigmoid cavity of the radius, and by its lower with the triangular fibro-cartilage; projecting internally and behind is the *styloid process*, to whose apex is attached the internal lateral ligament, to a depression at its base the fibro-cartilage; upon the posterior surface is a *groove* for the tendon of the extensor carpi ulnaris.

How is this bone developed?

By three centers: one for the shaft (eighth fetal week); one for the head (fourth year); one for the olecranon (tenth year, joining the shaft at the sixteenth year); head coössified with the shaft by the twentieth year.

Give the muscular attachments.

The triceps, anconeus, flexor carpi ulnaris, brachialis anticus, pronator teres, flexor sublimis and profundus digitorum, flexor longus pollicis (very often), pronator quadratus, flexor and extensor carpi ulnaris, supinator brevis, extensor ossis metacarpi and longus pollicis, and extensor indicis.

Describe the radius.

Shorter than the ulna, situated upon the outer side of the forearm, with a small upper extremity, forming only a small part of the elbow-joint, its lower end is large, forming the chief part of the wrist-joint. It is slightly curved and of a prismatic form. The *head* (upper extremity) (Fig. 61) is cylindrical, with a slightly cupped upper surface, articulating with the radial head of the humerus, by its sides with the lesser sigmoid cavity of the ulna and the orbicular ligament by which it is embraced; the constriction beneath the head is the *neck;* below and to the inner side is the *tuberosity*, rough toward its posterior margin for the biceps tendon, smooth in front for a bursa; the *shaft* is prismoid, curved outward, smaller above than below, having a sharp internal *interosseous border* for the interosseous ligament, with the *medullary foramen* directed upward at the junction of the middle and upper thirds of the *anterior surface.* This surface gives attachment to the flexor longus pollicis and pronator quadratus, and by an oblique line to the radial head of the flexor sublimis. The *external surface* gives attachment to the supinator brevis and pronator teres. The *posterior surface* (Fig. 62) gives attachment to the supinator brevis, extensor ossis metacarpi pollicis, and extensor brevis pollicis.

The lower *carpal extremity* has on its lower face an *articular surface* divided by a slight ridge into two facets for the semilunar and scaphoid bones; upon its inner side the shallow *sigmoid cavity* for the ulnar head; externally the *styloid process* giving attachment by its apex to the external lateral ligament, by its base to the supinator longus muscle; and on its posterior and external convex surfaces are five *grooves* for the extensor tendons.

How is this bone developed?

By three centers: one for the shaft (eighth fetal week):

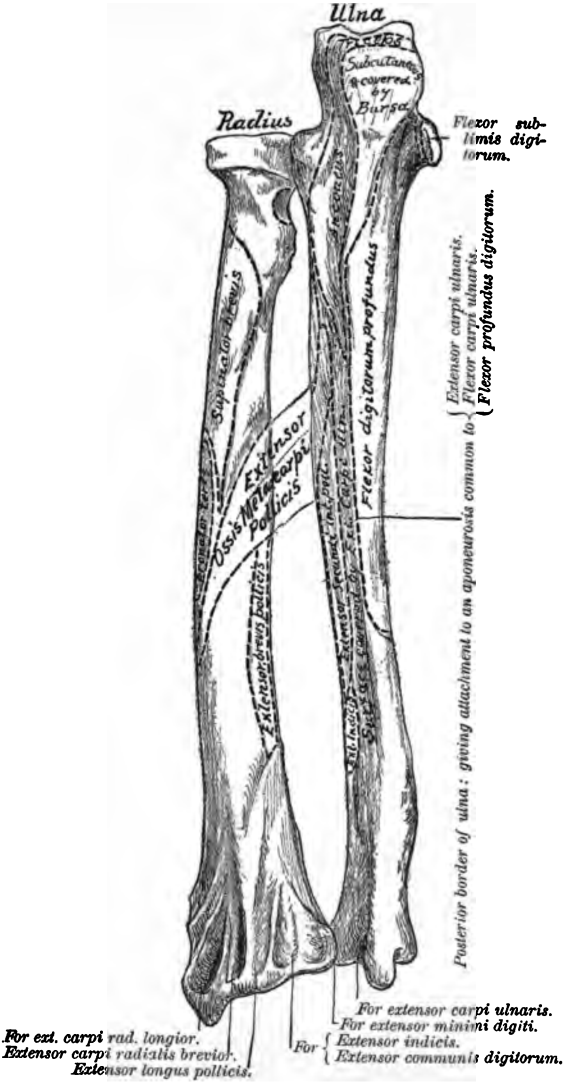

Ulna
Subcutaneous covered by Bursa
Radius
Flexor sublimis digitorum.
Anconeus
Supinator brevis
Flexor digitorum profundus
Extensor Ossis Metacarpi Pollicis
Pronator teres
Extensor brevis pollicis
Extensor Secundi Int. poll.
Surface covered by Ext. Carpi Ulr.
Ext. Indicis
Posterior border of ulna: giving attachment to an aponeurosis common to { Extensor carpi ulnaris. Flexor carpi ulnaris. Flexor profundus digitorum.
For extensor carpi ulnaris.
For extensor minimi digiti.
For { Extensor indicis. Extensor communis digitorum.
For ext. carpi rad. longior.
Extensor carpi radialis brevior.
Extensor longus pollicis.

FIG. 62.—Bones of the left forearm, posterior surface.

one for the carpal extremity (second year); and one for the head (fifth year, joins the shaft at puberty); bone coössified by about the twentieth year.

Give the muscular attachments.

The biceps, the supinator brevis, flexor digitorum sublimis and longus pollicis, pronator quadratus, the extensor ossis metacarpi and brevis pollicis, pronator teres, and supinator longus.

The Hand.

Into what segments is the hand divided?

Into the carpus (eight bones), metacarpus (five bones), and phalanges (fourteen bones); total, twenty-seven bones.

Describe the arrangement of the carpal bones.

They are placed in two rows of four each; thus, enumerating from the radial to the ulnar side, with palm upward; first, or *proximal row:* scaphoid^{s}, semilunar^{1}, cuneiform^{c}, pisiform^{p}; second, or *distal row:* trapezium^{t}, trapezoid^{1},^{t}, os magnum^{7}, unciform^{u}.

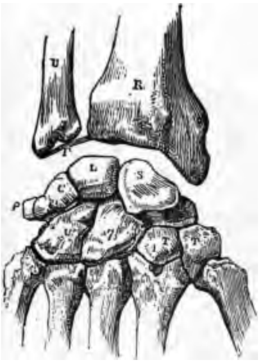


FIG. 63.—Right carpal bones, dorsal surface (Leidy).

With how many bones does each articulate?

Scaphoid, five; semilunar, five; cuneiform, three; pisiform, one; trapezium, four; trapezoid, four; os magnum, seven; unciform, five.

Describe the chief peculiarities of each bone (Figs. 63, 64, and 65).

The *scaphoid*^{s} (boat-shaped) has on the anterior surface a tuberosity; a transverse groove on the dorsum parallel to the convex articular surface for the radius; facets for the os magnum and semilunar bones on its inner surface; on its lower surface are facets for the trapezium and trapezoid.

The *semilunar*^{1} (half-moon) presents a convex facet above for the radius and a part of the triangular fibro-cartilage; on

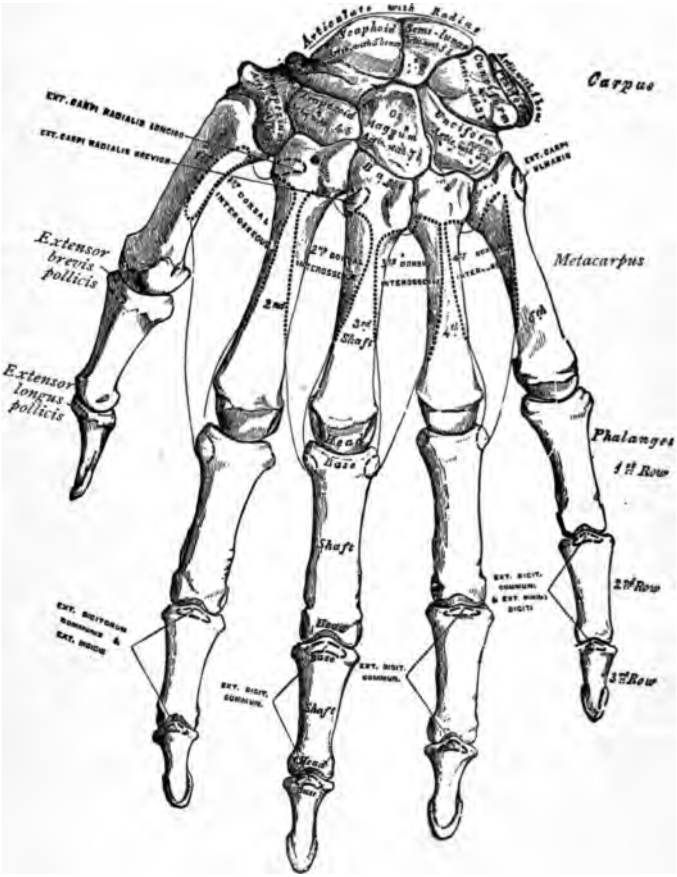


FIG. 64.—Bones of the left hand, dorsal surface (Gray).

its outer face a semilunar facet for the scaphoid; on its lower, a concave one for the os magnum and apex of the unciform; a quadrilateral one on the inner face for the cuneiform.

The *cuneiform*° (wedge-shaped) has an oval facet in front for the pisiform; one external for the semilunar; an inferior concavo-convex facet for the unciform; a superior convex facet for the triangular fibro-cartilage.

The *pisiform*[p] is rounded, with one ovoidal facet for the cuneiform.

The *trapezium*[t] is obliquely grooved on its palmar surface for the tendon of the flexor carpi radialis; superiorly is a concave facet for the scaphoid; below, a saddle-shaped one for the first metacarpal; internally, one large concave facet for the trapezoid, and a smaller one for the second metacarpal.

The *trapezoid*[tt] is wedge-shaped, apex palmar, has four articular surfaces touching, separated by sharp edges, the external for the trapezium; inferior (like a ridge-roof), for the second metacarpal; internal, for the os magnum; superior, for the scaphoid.

The *os magnum*[7] has superiorly a convex head for the scaphoid and semilunar, a neck and body; below, facets for three metacarpal bones; externally, one for the trapezoid; internally, one for the unciform.

The *unciform*[u] is triangular, has a sigmoid internal articular facet for the cuneiform; two facets below for the fourth and fifth metacarpals; one, external, for the os magnum; by apex with the semilunar; from the palmar surface projects the curved unciform process.

When do these bones ossify?

Os magnum and unciform, during the first year; cuneiform, third year; trapezium and semilunar, fifth year; scaphoid, sixth year; trapezoid, during the eighth year; pisiform, about the twelfth year.

(The muscular attachments to the carpal and tarsal bones will be given under the Muscular System.)

Describe the metacarpal bones.

They are five long bones, with shaft, head, and base. The *first metacarpal* (sometimes considered a phalanx) is shorter, has only one facet on the base, and has one ossific center for the shaft (eighth fetal week) and one for the *base* (third year). The *second metacarpal* has four facets on the base for the trapezium, trapezoid, os magnum, and third metacarpal; it, in common with the rest, has one ossific center for the shaft

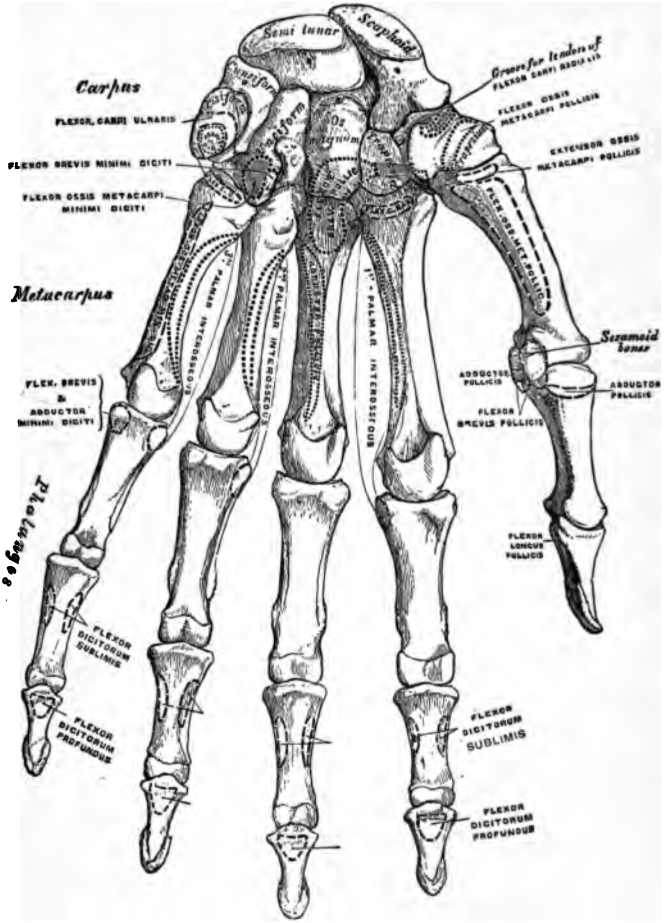

Semi lunar
Scaphoid
Carpus
Cuneiform
Pisiform
Unciform
Os magnum
Trapezoid
Trapezium
Groove for tendon of FLEXOR CARPI RADIALIS
FLEXOR CARPI ULNARIS
FLEXOR OSSIS METACARPI POLLICIS
FLEXOR BREVIS MINIMI DIGITI
EXTENSOR OSSIS METACARPI POLLICIS
FLEXOR OSSIS METACARPI MINIMI DIGITI
FLEX. OSS. MET. POLLICIS
Metacarpus
PALMAR INTEROSSEOUS
PALMAR INTEROSSEOUS
PALMAR INTEROSSEOUS
Sesamoid bones
ABDUCTOR POLLICIS
ABDUCTOR POLLICIS
FLEX. BREVIS & ABDUCTOR MINIMI DIGITI
FLEXOR BREVIS POLLICIS
Phalanges
FLEXOR LONGUS POLLICIS
FLEXOR DIGITORUM SUBLIMIS
FLEXOR DIGITORUM SUBLIMIS
FLEXOR DIGITORUM PROFUNDUS
FLEXOR DIGITORUM PROFUNDUS

FIG. 65.—Bones of the left hand, palmar surface (Gray).

(eighth fetal week) and one for the *head* (third year; they coössify by the twentieth year). The *third metacarpal* articulates with the os magnum; on the ulnar side it has two small facets for the fourth metacarpal, and a single facet on the radial side for the second metacarpal; the outer angle of its base is the styloid process. The *fourth metacarpal* has two facets for the unciform and the os magnum, a single facet on the ulnar side for the fifth metacarpal, and two small ones on the radial side for the third metacarpal. The *fifth metacarpal* articulates with the unciform by a concavo-convex facet, has only a lateral facet on the radial side for the fourth metacarpal, and on the ulnar side a prominent tubercle for the extensor carpi ulnaris tendon.

Describe the phalanges.

They are fourteen in number—three for each finger, and two for the thumb—they are long bones, having a shaft, base, and condyles, except those of the distal row. The bases of the first row, cup-shaped, articulate with the heads of the metacarpals; those of the second and third have a double concavity, separated by a median ridge, and articulate with the condyles of the row above; the distal extremities of the ungual phalanges have rough, horse-shoe shaped tubercles, *ungual processes*, on their palmar surfaces for attachment of the pulp of the finger; they ossify by one center for the shaft (eighth fetal week), and one for the base (third to fifth year); uniting in from eighteen to twenty years.

BONES OF THE LOWER EXTREMITY.

They include those of the *hip*, *thigh*, *leg*, and *foot*.

The Thigh.

Describe the femur.

It is the longest bone of the skeleton, and inclines toward its fellow to bring the knee-joint near the center of gravity during walking, this obliquity being greater in the female, from the breadth of the pelvis, and in a short person than in a tall one of either sex.

The *head* (Fig. 66), forming rather more than a hemisphere, directed upward, inward, and forward, has behind and below its center the *fossa capitis* for the ligamentum teres. The *neck*, joining the head with the shaft, is flattened and pyramidal; in the adult male it forms an obtuse angle with the shaft of about

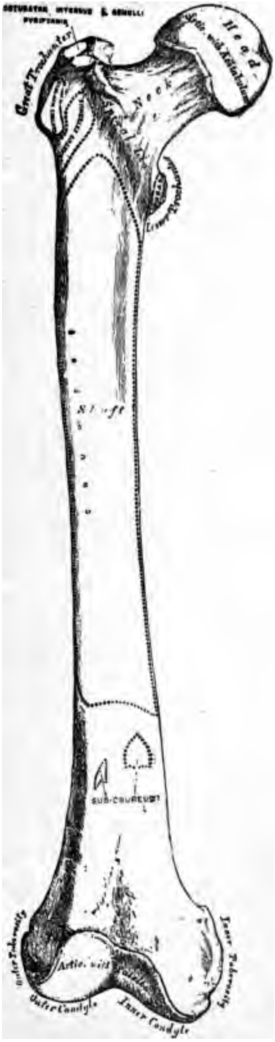


FIG. 66.—Right femur, anterior surface.

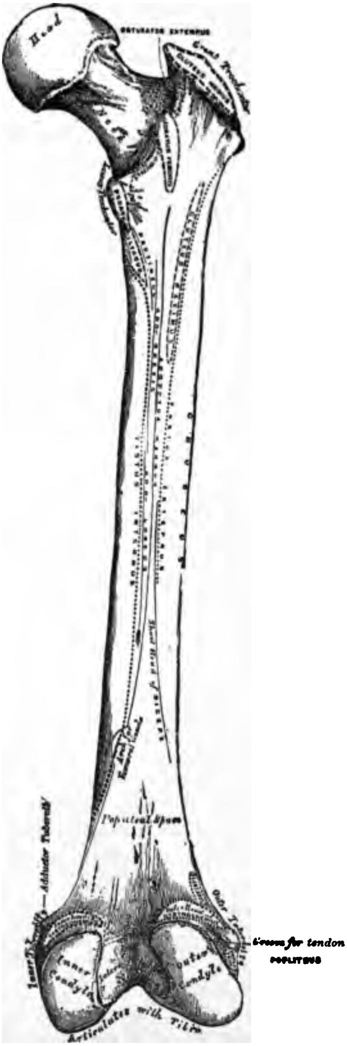


FIG. 67.—Right femur, posterior surface.

(Gray.)

125°. After ossification is completed, twenty years, this angle does not change nor does the neck become *horizontal.*

The *great trochanter* is a large, irregular, quadrilateral eminence, directed upward, outward, and backward, marked on its external surface by a *diagonal line* for the gluteus medius; below and behind this is a smooth surface for a bursa beneath the gluteus maximus; in front is inserted the gluteus minimus; superiorly is the pyriformis; and upon its inner surface is the *digital fossa* for the tendon of the obturator externus muscle; and above that the internal obturator and gemelli muscles are inserted.

The *lesser trochanter* (Fig. 67), small and conical, projects from the lower back part of the base of the neck, receiving the insertion of the psoas muscle above and the iliacus below.

The *anterior* and *posterior intertrochanteric lines* connect these processes, the latter being the more prominent, while to the former is attached the anterior portion of the capsular ligament. At the middle of the posterior intertrochanteric line is a *tubercle* for the quadratus femoris muscle, sometimes a *linea quadrati.*

The *shaft*, broad and cylindroid at either extremity, narrow and triangular in the center, slightly curved forward, has its *medullary foramen* at the junction of the middle and lower thirds of its posterior surface, directed upward; and from its anterior surface arise the crureus and subcrureus muscles.

The *linea aspera*, a prominent longitudinal ridge occupying the middle third of the posterior surface, has an external and an internal lip, and an intermediate space; above, it divides into three lines, one directed upward to the base of the greater, one to the base of the lesser trochanter, a third, the most internal, continuous with the anterior *intertrochanteric line*, forming with it the *spiral line*, while below the linea aspera bifurcates to inclose the smooth *popliteal space*, the inner division *grooved* for the femoral vessels. In general terms, this line and its subdivisions have attached the following muscles: the vastus internus and externus, the pectineus, the three adductors, the short head of the biceps, and the gluteus maximus.

Of the two *condyles*, the *internal* is the longer by about half an inch, to bring both condyles on the same horizontal plane in the normally oblique position of the femur; above each condyle, behind, is a *depression* for the gastrocnemius (above the *external* the plantaris muscle also originates); separating them is the *intercondyloid notch*, to whose sides are attached the crucial ligaments; in front, the condyles form a continuous articular surface, the *trochlea;* the outer, as well as the inner, condyle presents an *epicondyle* upon its free surface for the lateral ligaments, beneath which, on the outer condyle, is a *groove* for the tendon of origin of the popliteus muscle; above the internal condyle is a small *adductor tubercle* for the tendon of the adductor magnus.

Give the development of the femur.

By five centers: one for the shaft (fifth fetal week); one for the condyles (ninth fetal month); one for the head (end of the first year); one for the greater trochanter (fourth year); one for the lesser trochanter (thirteenth to fourteenth year); all coössified by the twentieth year in the *reverse order of their appearance.*

Give the muscular attachments.

The three glutei, pyriformis, two obturators, gemelli, quadratus, psoas, iliacus, two vasti, short head of biceps, pectineus, three adductors, crureus, subcrureus, gastrocnemius, plantaris, and popliteus.

The Patella.

Describe the patella (Fig. 68).

It is flat, triangular, placed at the front of the lower end of the femur, and, being developed in the quadriceps tendon, is probably a sesamoid bone; the convex *anterior surface* is roughened; the *posterior surface* is divided by a vertical *ridge* into two smooth *facets* for the trochlea, the outer being the

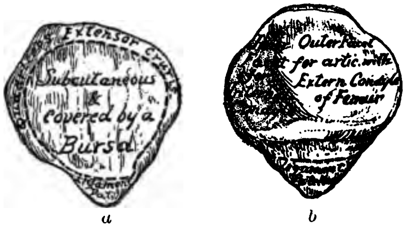

Extensor Cruris
Subcutaneous & Covered by a Bursa
Ligament Patellæ
Outer Facet for artic. with Extern. Condyle of Femur
a
b

FIG. 68.—Right patella: *a*, anterior surface; *b*, posterior surface.

broader and deeper; the apex gives attachment to the ligamentum patellæ; and the superior and lateral borders to the rectus femoris, crureus, and vasti muscles. It is developed by one center (about the third year); the muscular attachments have been already given.

The Leg.

Describe the tibia.

The shin-bone, situated at the inner front part of the leg, is only second in length to the femur; the *head*, or upper extremity, is large and expanded on each side into two lateral *tuberosities*, bearing upon their upper surfaces smooth concave *ovoidal facets* for the femoral condyles, between which is the vertical, bifid *spine* for the extremities of the semilunar fibrocartilages, the depressions in front and behind its base giving origin to the crucial ligaments. Below, in the mid-line, in front of the head, is the *tubercle* for the ligamentum patellæ (Fig. 69); separating the tuberosities behind is the *popliteal notch*, giving attachment to the posterior crucial ligament; on the posterior surface of the inner tuberosity is a transverse *groove* for the insertion of the semimembranosus tendon; upon the back of the outer tuberosity, facing downward, is a *facet* for the head of the fibula; running obliquely from this facet, downward and inward, on the *posterior surface* (Fig. 70), is the *oblique line* for the popliteal fascia and muscle, part of the soleus, flexor longus digitorum, and tibialis posticus muscles; just below the line, directed downward, is the *medullary* canal, the largest in the skeleton. The *external surface* (Fig. 69) gives attachment to the tibialis anticus. The *internal surface* is largely subcutaneous; it gives attachment above to the sartorius, gracilis, and semitendinosus.

The prismoid shaft has three borders, the anterior, called the *crest* or *shin*, and the external or *interosseous* ridge, for the interosseous membrane, and the *internal* for the soleus and flexor longus digitorum. The *lower extremity*, smaller than the upper, has an inferior concave surface for the astragalus, an external rough triangular surface for articulation with the fibula; it is grooved posteriorly for the flexor longus hallucis tendon; has projecting downward internally the *internal malleolus*, which articulates by its outer surface with the side of the astragalus, is grooved behind for the tibialis posticus and flexor longus

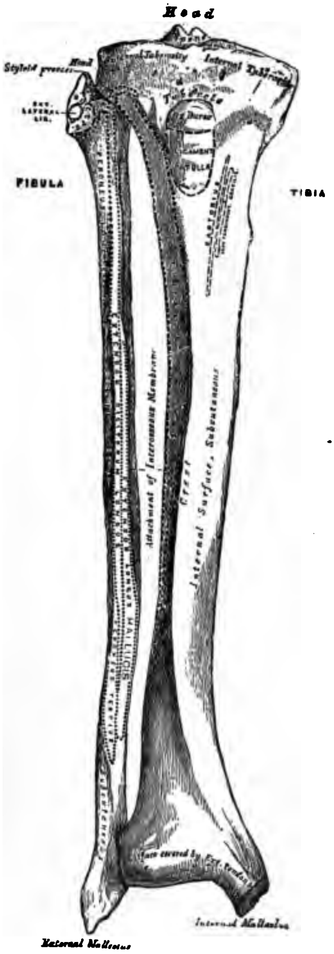


Fig. 69.—Bones of the right leg, anterior surface.

(Gray.)

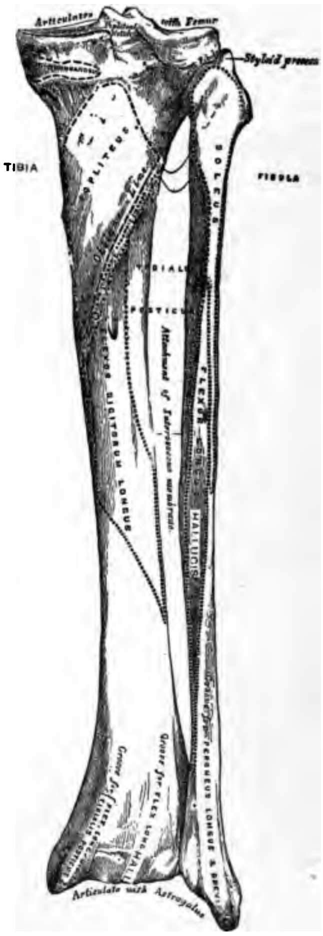


Fig. 70.—Bones of the right leg, posterior surface.

digitorum tendons, and has attached to its tip the internal lateral ligament.

How is this bone developed?

By three centers: one for the shaft (seventh fetal week); one for the head (before or at birth); one for the lower end (second year); bone coössified by the twenty-first or twenty-second year.

Give the muscular attachments.

Semimembranosus, tibialis anticus and posticus, biceps, extensor and flexor longus digitorum, sartorius, gracilis, semitendinosus, popliteus, soleus, and quadriceps femoris by the ligamentum patellæ.

Describe the fibula (peroneal bone).

It is long, slender, and is placed externally nearly parallel to the tibia.

The *head* or upper end articulates by a flattened facet with the external tibial tuberosity, and is prolonged upward behind into the *styloid process* for the short external lateral ligament; below and behind is attached the long external lateral ligament and the biceps tendon.

The *shaft*, triangular and twisted (Figs. 69 and 70), has four borders and four surfaces; the borders are *antero-external*, *antero-internal* (interosseous), *postero-external*, and *postero-internal;* the surfaces are *anterior*, *external*, *posterior*, and *internal.* To the *anterior surface* are attached the extensor longus hallucis, extensor longus digitorum and peroneus tertius muscles; to the *external surface*, the peroneus brevis and longus; to the *posterior surface*, the soleus and flexor longus hallucis; to the *internal surface*, the tibialis posticus. The *external malleolus* forming the lower extremity, longer than the internal, articulates by its inner surface with the outer side of the astragalus; is grooved behind for the peroneus longus and brevis tendons; to its summit is attached the middle, and to rough *depressions* in front and behind, the anterior and posterior fasciculi of the external lateral ligament of the ankle.

Describe its development.

By three centers: one for the shaft (eighth fetal week); one for the malleolus (second year); one for the head (fourth year); bone coössified by the twenty-fifth year, but, *contrary to rule*, the lower epiphysis unites *first.*

Give the muscular attachments.

Biceps, soleus, three peroneals, the extensor and flexor of the great toe, the extensor longus digitorum, and tibialis posticus.

The Foot.

Into what segments are the bones of the foot divided?

Into the *tarsus* (7); *metatarsus* (5); and *phalanges* (14); total, 26 bones (Figs. 71, 72 and 73).

Name the tarsal bones.

Calcaneum[3] (os calcis), astragalus[1], cuboid[8], navicular[4], internal[5], middle[6], and external[7] cuneiform.

Give the chief peculiarities of each tarsal bone.

The *astragalus*[1] has a large rounded *head*[2], a *neck*, a *body*[1], superiorly a *trochlear surface* broader in front than behind, for the tibia, and continuous with it on either side *facets* for the internal and external malleolus; the under surface presents two articular *facets*, separated by a groove for the calcaneo-astragaloid ligament, running obliquely forward and outward; that behind for the calcis, that in front partly for the calcis, but chiefly for the calcaneo-navicular ligament; it articulates with the tibia, fibula, os calcis, and navicular, and is *developed* by one center (seventh fetal month).

The *os calcis*[3], the largest tarsal bone, forms by its *tuberosity*[3] the heel, has a *groove* on its upper surface to correspond to that of the astragalus; behind and in front of which are two articular *facets* for the same bone: on the inner side projects the *sustentaculum tali* supporting the internal articular surface; beneath this process the inner surface of the bone is deeply concave for the flexor tendons, plantar vessels, and nerves; its anterior concavo-convex surface articulates with the cuboid; on the under surface are an *inner* and an *outer tubercle;* it articulates with the astragalus and cuboid, and is *developed*

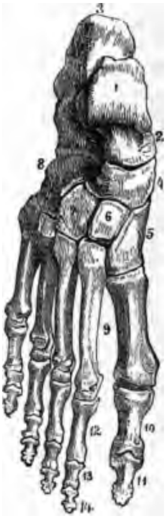


FIG. 71.—Bones of the right foot, dorsal surface (Leidy).

from two centers, one for the main mass (sixth fetal month) and one for the tuberosity (tenth year); union after puberty.

The *cuboid* has one articular surface each for the os calcis, external cuneiform, the fourth and fifth metatarsals, and sometimes for the navicular; upon the under surface is a deep *groove* for the peroneus longus tendon, and behind this a *ridge* terminating externally in a *tuberosity;* it is *developed* from one center (ninth fetal month).

The *navicular*, situated internally, is concave behind for the head of the astragalus; is convex in front with three *facets* for the three cuneiform bones; externally there may be a *facet* for the cuboid; and internally, below, is the *tuberosity* for part of the posterior tibial tendon; it is *developed* from one center (fourth year).

The *internal cuneiform*, the largest, is placed at the inner side of the foot, has its base downward, upon which is the *tuberosity* for partial insertions of the tibialis posticus and anticus tendons; in front is a kidney-shaped *facet* for the first metatarsal; externally are two *facets* for the second metatarsal in front, the middle cuneiform behind; posteriorly a *facet* for the navicular; it is *developed* by one center (third year).

The *middle cuneiform*, the smallest, has its base upward, a triangular *facet* in front for the second metatarsal, another behind for the navicular, along the posterior and superior borders of the inner face a *facet* for the internal cuneiform; and externally a smooth facet for the external cuneiform; it is *developed* by one center (fourth year).

The *external cuneiform* is intermediate in size with its base upward, has an anterior triangular *facet* for the third metatarsal; another posterior for the navicular; two upon the internal surface for the second metatarsal and middle cuneiform; and two upon the outer surface for the fourth metatarsal and for the cuboid: it is *developed* by one center (first year).

Describe the metatarsal bones.

These five long bones have prismoid shafts[9], anteriorly a *head* for articulation with the phalanges, posteriorly a *base* articulating with the tarsus and with one another.

The *first metatarsal* is shorter, much stouter than the others, and articulates with the internal cuneiform: *developed* by one

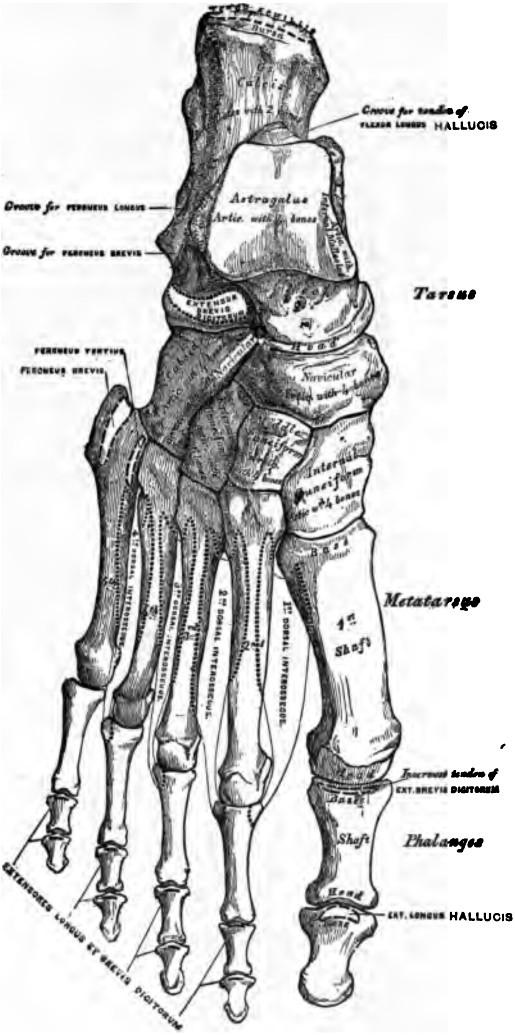


FIG. 72.—Bones of the right foot, dorsal surface (Gray).

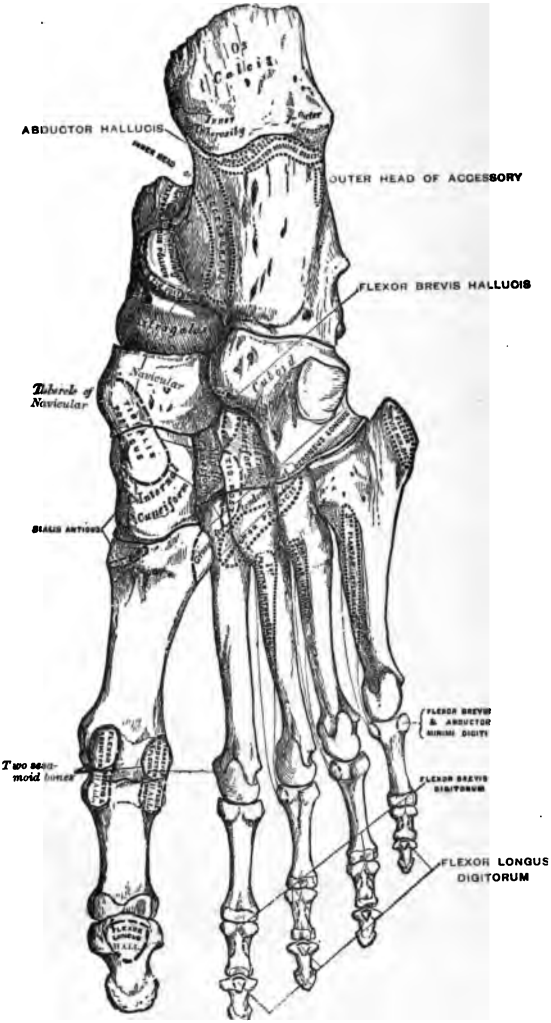


Fig. 73.—Bones of the right foot, plantar surface (Gray).

center for the *shaft* (seventh fetal week); one for the *base* (third year), united by the twentieth year.

The *second metatarsal*, the longest, articulates posteriorly with the middle cuneiform, internally with the internal cuneiform, externally with the external cuneiform and third metatarsal, four bones in all: *developed* by one center (seventh fetal week) for the *shaft*, one for the *head* (third year), united at twenty years.

The *third metatarsal* has a *facet* on the base for the external cuneiform, two on its inner side and one on its outer for the contiguous metatarsal: *developed* like the second.

The *fourth metatarsal* articulates behind with the cuboid, has a *facet* on the inner side divided into an anterior portion for the third metatarsal, a posterior for the external cuneiform, and externally one *facet* for the fifth metatarsal, under which is a deep groove: *developed* like the second.

The *fifth metatarsal* has a triangular oblique surface for the cuboid, continuous internally with one for the fourth metatarsal; externally a tubercular *eminence: developed* like the second.

Describe the phalanges.

They resemble closely those of the hand, except that they are strongly compressed from side to side, instead of from before backward: ossification also similar, but later. Thus, the shaft centers appear from the second to the fourth month, and the epiphyses appear at the bases in the fourth to the eighth year.

THE ARTICULATIONS.

How are the articulations classed?

In three divisions: 1. *Synarthrosis*, immovable, as most of the cranial articulations; 2. *Hemiarthrosis*, yielding (limited motion), as that between the vertebral bodies, or at the pubic symphysis; 3. *Diarthrosis*, freely movable.

Into what classes are the synarthroses divided?

1. *Synchondrosis*, union by cartilage, as sacro-iliac joint; 2. *Syndesmosis*, union by ligament, as sutures; 3. *Synostosis*, union by bone, as spheno-occipital. Sutures are true and false.

1. *Sutura vera*, including three sub-classes—S. dentata,

tooth-like, as the interparietal suture; *S. serrata*, like saw teeth, as the interfrontal; *S. limbosa*, when bevelled in addition to dentation, as the fronto-parietal. The *S. notha* (false suture) includes *S. squamosa*, formed by two overlapping bevelled edges, as the squamo-parietal suture; and the *S. harmonia*, mere apposition of roughened surfaces, as the two superior maxillary bones.

2. *Schindylesis*, where a thin edge is received into a cleft or groove, as the vomer between the superior maxillary and palate bones.

3. *Gomphosis*, the insertion of a conical process into a socket, as teeth in their alveoli (not really a bony articulation, as teeth are *not* bones).

How are diarthroses classed?

As *arthrodia*, gliding joints in tarsus and carpus; *enarthroses*, ball-and-socket joint—hip- or shoulder-joints; *ginglymus*, hinge-joint—elbow-joint; *trochoides*, or *lateral ginglymus*, a pivot turning within a ring, as the superior and inferior radio-ulnar and central atlanto-axial; *condyloid* where surfaces are elliptical, as radio-carpal (wrist); *reciprocal reception*, or saddle-shaped surfaces, as first carpo-metacarpal (base of thumb).

Motions.—Flexion, extension, adduction, abduction, circumduction (a combination *in succession* of the four), rotation, and gliding.

What structures are essential to the formation of each of the three classes of articulations?

For *synarthroses*, two or more bones, an interposed layer of fibrous tissue (sutural ligament) or, perhaps, cartilage (base of the skull); *symphyses*, an interposed bond of fibro-cartilage, with strong bands of white fibrous tissue, *i. e. ligaments* (ligaments are sometimes composed of yellow elastic tissue, as the ligamenta subflava or ligamentum nuchæ); *diarthroses*, two or more cartilaginous-coated surfaces (reducing friction), sometimes interarticular fibro-cartilages to deepen joint-surfaces, as those of the knee and temporo-maxillary joints, a complete fibrous capsule, and often additional ligamentous bands, some interarticular, *i.e.* within the joint-cavity, and a synovial (serous) membrane lining the interior of the capsule, but not extending upon the cartilages; a similar membrane also forms sacs (bursæ) outside the joints, with which they often communicate, serving to reduce friction of the tendons, ligaments, etc.; the layer of bone beneath the articular cartilage is the denser *articular lamella;* it contains neither Haversian canals nor canaliculi, but has larger lacunæ.

What is the rule as regards the nerve-supply of joints?

The interior of the joint, the muscles moving it, and the skin over their insertions, are supplied by the same trunk or trunks of nerves (this explains the reflex contractions of diseased joints.

The Articulations of the Trunk.

Describe the vertebral articulations.

Formed by the contiguous surfaces of the bodies, laminæ, articular, spinous, and transverse processes; their ligaments are:

An *intervertebral connecting fibro-cartilage*, or *disk*, between the bodies of all true vertebræ, except the atlas and axis.

An *anterior common ligament*[3] passing medianly over the fronts of the vertebral bodies, most firmly attached to their margins.

A *posterior common ligament*, similarly disposed behind the bodies.

Short or *lateral vertebral ligaments*, fibers running at most over three vertebræ, firmly uniting the bodies where the anterior and the posterior common ligaments are deficient.

Ligamenta subflava, of yellow elastic tissue, connecting the laminæ from an internal surface above to an upper edge below.

Capsular[6], enclosing the articular processes, and lined with synovial membrane.

Supra- and *interspinous*, the former connecting the tips, the latter being interposed between the spinous processes.

Intertransverse, connecting transverse processes; *nerves*, spinal in each region; *arteries*, vertebral, pharyngeal, and ascending cervical arteries in the neck, intercostal arteries in the thoracic region, and lumbar arteries in the loin.

Describe the occipito-atlantal articulation.

A pair of *ginglymo-arthrodial joints* formed by the condyles of the occipital bone and the superior articular processes of the atlas. Its ligaments are:

Two *anterior occipito-atlantal*[2] (Fig. 74), extending from the anterior margin of the foramen magnum to the anterior arch of the atlas, blending on either side with the capsular ligaments; the second ligament is a rounded cord in the middle line.

A *posterior occipito-atlantal*, much broader, from the posterior margin of the foramen magnum between the condyles, to the postero-superior border of the posterior arch of the atlas, and is incomplete on each side for the ingress of the vertebral artery and egress of the suboccipital nerve.

Two *capsular ligaments*[7], lined with synovial membrane, surrounding the articular surfaces.

Two *lateral* (or *anterior oblique*), passing upward and inward from the transverse process beyond the vertebral foramen to the jugular process of the occipital bone; *nerve*, suboccipital; *arteries*, from the vertebral.

Describe the atlanto-axial articulation.

The lateral joints are *arthrodia*, that between the atlas and odontoid process is *trochoides*. The ligaments of the lateral joints and arches are:

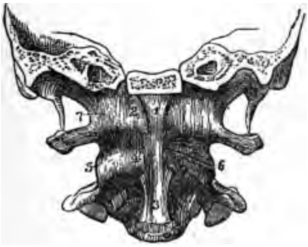


FIG. 74.—Occipito-atlantal and atlanto-axial ligaments, anterior view.

Two *anterior atlanto-axial*[4], membranous, passing between the lower front border of the atlas to the front of the axis with a central rounded cord.

The *posterior atlanto-axial*, stretching between the postero-inferior edge of the ring of the atlas to the superior edge of the arch of the axis behind; it is pierced on each side by the second cervical nerve.

The *anterior*[1-3] *common* ligament is continued over the median portions of the above to the occiput, as rounded cords.

Two *capsular*[5,6], synovial-lined, surrounding the articular processes.

The ligaments of the central atlanto-axial joint are:

The *transverse*[2] (Fig. 75), extending between the tubercles on the inner surface of each lateral mass of the atlas; it holds the odontoid process in place, and between the two is a synovial membrane surrounded by a *capsule*, the *transverso-odontoid joint;* between the odontoid process and the posterior surface of the anterior arch of the atlas is the atlanto-odontoid articulation, surrounded by a *capsule* lined with synovial membrane; passing upward and downward from the transverse ligament are two bands, attached above to the basilar margin of the foramen magnum; below, to the upper half of the body of the axis, forming a cross: hence the transverse ligament may be called the *crucial ligament; nerves*, all these joints are supplied by the second cervical or the loop between it and the suboccipital; *arteries*, are branches of the vertebral.

What ligaments connect the axis and occiput?

The *posterior common ligament*[1] extends upward, to be attached far up the basilar process; this ligament is usually regarded as

The *occipito-axial* or *occipito-cervical ligament*, attached above to the basilar groove of the occiput, below, to the third cervical body and that of the axis (next comes the vertical part of the crucial already described); deepest of all are the three odontoid ligaments—two *lateral occipito-odontoid*, or *check*[5], extending from the sides of the apex of the odontoid to the inner edge of the occipital condyles, while stretching between the odontoid tip and the under surface of the basilar

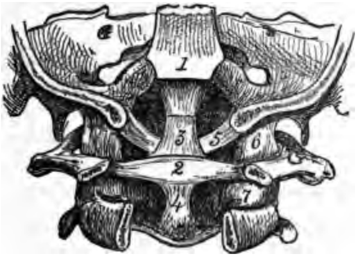


FIG. 75.—Occipito-axial and atlanto-axial ligaments, posterior view.

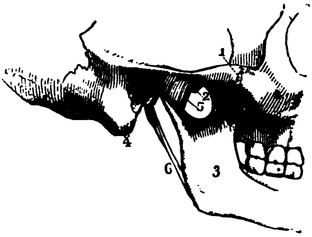


FIG. 76.—Temporo-maxillary articulation, external view.

process, close to the foramen magnum, is the *central occipito-odontoid*, or *ligamentum suspensorium.*

Describe the temporo-maxillary articulation.

The upper compartment is *arthrodial*, formed by the glenoid fossa and eminentia articularis of the temporal bone and the upper surface of the fibro-cartilage; the lower is *ginglymoid*, between the under surface of the fibro-cartilage and the condyle of the lower jaw. The ligaments are *capsular*, passing between the maxillary and temporal bones near their margins, consisting of ligamentous fibers, which are thicker at certain parts and are described as:

The *external lateral ligament*[5], attached above to nearly the whole length of the lower edge of the zygoma and its tubercle, below to the outer side of the neck of the condyle of the jaw.

The *short internal lateral ligament*, extending between the spine of the sphenoid and inner edge of the glenoid fossa, and a ridge on the inner side of the neck of the condyle.

The *long internal lateral ligament* (spheno-mandibular ligament), stretching between the spine of the sphenoid and the forepart of the tip of the inferior dental foramen, the lingula.

The *interarticular fibro-cartilage*, concavo-convex on the upper surface, concave transversely below, dividing the joint into two separate synovial cavities.

The *stylo-maxillary ligament*[6], extending from the styloid process to the angle of the jaw, is really a process of the deep fascia; *nerves*, the masseteric and auriculo-temporal branches of the inferior maxillary nerve; *arteries*, temporal, middle meningeal, ascending pharyngeal, posterior auricular, tympanic branch of the internal maxillary, and ascending palatine.

Describe the costo-vertebral articulations.

These are each formed (1) between the head of a rib and the bodies of two adjoining vertebræ (except the first, tenth, eleventh, and twelfth, which articulate with but one vertebra each), being *ginglymo-arthrodial;* and (2) between the tuberosity of each rib (except the eleventh and twelfth) and the transverse process of a vertebra, and is *arthrodial.*

Describe the costo-central articulations.

The ligaments are:

A *capsular ligament*[4], attached all around each articular surface, the synovial lining being subdivided into two cavities by the

Interarticular ligament[4], passing between the ridge on the head of the rib to the intervertebral fibro-cartilage.

The *stellate ligament*[2], or *anterior costo-central*, arising from the anterior surface of the head of the rib, whence the fibers radiate to the vertebra next above, and below to the adjoining vertebra, and to the intervertebral disk; *nerves*, anterior branches of the spinal nerves; *arteries*, the intercostals.

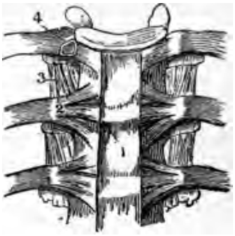


Fig. 77.—Costo-vertebral ligaments, anterior view.

Describe the costo-transverse articulations.

Arthrodial, ten in number, their ligaments are:

Capsular, attached beyond the margins of the articular facets.

Superior costo-transverse[3] has two sets of fibers; the anterior passing between the upper border of the neck of the rib to the transverse process of the vertebra above; the posterior to the articular and transverse processes.

Middle costo-transverse, connecting the back of the neck of the rib with the contiguous transverse process; it has three parts, upper and lower and a *conjugal ligament* passing through the spinal canal.

Posterior costo-transverse, stretching from the tip of the transverse process to a rough projection beyond the facet on the tuberosity of the rib; *nerves*, posterior branches of the thoracic nerves; *arteries*, intercostals and posterior spinal.

Describe the (1) chondro-sternal articulations, (2) the connection between the ribs and costal cartilages, and (3) the interchondral joints.

(1) The first, sixth, and seventh are *synarthrodial*, the other joints are *arthrodial*. The first, sixth, and seventh have no synovial membrane; the third, fourth, and fifth have one; the second has two. The ligaments are *capsular;* the anterior and posterior thicker segments are described as

Anterior and posterior chondro-sternal ligaments. Occasionally there is an *interarticular ligament*, notably in the second chondroid joint, dividing the synovial cavity into two.

(2) The *costal cartilages* are firmly attached to the cup-like depression at the end of each rib, and by the periosteum continued over to form the perichondrium.

(3) The *interchondral articulations*, *arthrodial*, are found between the edges of the cartilages of the sixth, seventh, and eighth ribs, sometimes the fifth and ninth, having each a *capsule* lined with synovial membrane. In addition there is an *anterior* and a *posterior chondro-xiphoid ligament* which binds the xiphoid cartilage and the sixth and seventh cartilages together; *nerves*, intercostals; *arteries*, internal mammary or its branches.

Describe the ligaments of the sternum.

The manubrium and gladiolus are bound together by the *anterior* and *posterior intersternal ligaments*, with a layer of cartilage between them (an *amphiarthrodial joint*, sometimes a *diarthrodial*); that between the ensiform cartilage and the gladiolus is *synarthrodial.*

Describe the sacro-vertebral articulation.

Similar to other vertebral articulations, but has, in addition,

The *sacro-lumbar ligament*, extending from the transverse process, pedicle, and body of the fifth lumbar vertebra to the non-articular portion of the base of the sacrum and periosteum of the ilium, and anterior sacro-iliac ligament.

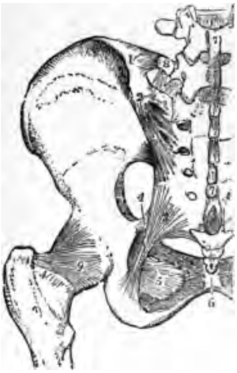


FIG. 78.—Ligaments of pelvis and hip, posterior view.

The *ilio-lumbar ligament*[1] (Fig. 78), extending from the front surface and tip of the transverse process of the fifth, and lower edge and front surface of the transverse process and pedicle of the fourth lumbar vertebra, to the inner lip of the iliac crest; *nerves*, fourth and fifth lumbar, sympathetic; *arteries*, ilio-lumbar, last lumbar, and lateral sacral.

Describe the sacro-iliac articulations.

They are *synarthrodial*, formed between the auricular surfaces of the ilium and sacrum, and have the following ligaments upon each side, in addition to the symphyseal cartilage:

The *anterior sacro-iliac*[3] (Fig. 81), from the three first pieces of the sacrum to the ilium on their pelvic surfaces.

The *posterior sacro-iliac*[2] (Fig. 78), very strong, extending between the back of the sacrum and the posterior two inches of the iliac crest, including the posterior superior iliac spine.

An *oblique ligament*, stretching between the third articular tubercle of the sacrum to the posterior superior iliac spine.

Superior and inferior bands of fibrous tissue closing in the joint above and below, belong to the anterior sacro-iliac.

The *interosseous ligament*, strongest of all, consists of numerous ligamentous bands passing between the contiguous rough surfaces of the sacrum and ilium; *nerves*, from the superior gluteal, posterior sacral, and lumbo-sacral cords; *arteries*, the gluteal, ilio-lumbar, and lateral sacral.

Describe the ligaments connecting the sacrum and ischiatic bones on each side.

They are the:

Greater sacro-sciatic[3], thin, triangular, passing from the posterior inferior iliac spine, fourth and fifth articular sacral tubercles and lower lateral margin of the sacrum, and from the coccyx to the inner margin of the ischiatic tuberosity, forming here the *falciform process.*

The *lesser sacro-sciatic*[4], anterior to the former, of same shape, stretching between the lateral margins of the sacrum and coccyx and the spine of the ischium. It is blended with the coccygeus muscle.

These ligaments convert the two sacro-sciatic notches into the *greater* (by lesser ligament) and the *lesser* (by greater ligament) *sacro-sciatic foramina*, described under the iliac and ischiatic bones.

Describe the sacro-coccygeal articulation.

Amphiarthrodial, its ligaments are:

An *interarticular fibro-cartilage*, like that between vertebræ.

An *anterior sacro-coccygeal*, a continuation of the anterior common vertebral.

A *posterior sacro-coccygeal*, a continuation of the posterior common, of the supraspinous and interspinous ligaments and the filum terminale.

Intercornual and *intertransverse* bands, connecting parts of the same name; *nerves*, anterior and posterior branches of the fifth sacral and coccygeal, posterior division of the fourth, and probably the second and third sacral; *arteries*, lateral and median sacral.

Describe the pubic articulation.

Amphiarthrodial, between the two pubic bones; its ligaments are:

An *interosseous fibro-cartilage*, or *interpubic disk*.

A *suprapubic*, extending along the crest of the pubes on each side, blending with the fibro-cartilage.

A *posterior*, little more than periosteum.

An *anterior*, thick, strong, decussating, attached to the contiguous portions of the body and rami.

An *inferior*, or *subpubic*, arched, filling up the angle between the pubic rami; *nerves* and *arteries* of no special moment.

The *obturator ligament*[5] is a fibrous membrane filling the same named foramen, except at the upper and outer part.

The Articulations of the Upper Extremity.

Describe the sterno-clavicular articulation.

An *arthrodial* joint formed between the sternal end of the clavicle and the sternum and cartilage of the first rib, having an interarticular fibro-cartilage usually dividing the joint into two distinct synovial sacs; its ligaments are:

A *capsular*, passing between the articular margins and firmly connected with the fibro-cartilage. Its strengthening bands are the *anterior* and *posterior sterno-clavicular ligaments*.

The *interclavicular*, passing from the posterior superior angle of the inner extremity of each clavicle, and attached to the sternum between.

The *rhomboid*, or *chondro-clavicular*, stretching from the upper border of the first costal cartilage to the rhomboid impression of the clavicle; *nerves*, from the descendens cervicalis and from the nerve to the subclavius; *arteries*, contiguous muscular branches.

Describe the acromio-clavicular articulation.

An *arthrodial* joint formed by the outer extremity of the clavicle and the acromion process of the scapula; it rarely has complete interarticular fibro-cartilage and two synovial sacs, otherwise there is only one sac; its ligaments are, the *capsular*, attached to the anterior and posterior borders, upper and lower surfaces of the acromion and clavicle; the *superior* and *inferior acromio-clavicular ligaments.*

The *coraco-clavicular*[2], composed of the *conoid*[2], conical, attached by its apex to the base of the coracoid process, by its base to the conoid tubercle of the clavicle and a line internal to it (Fig. 79).

The *trapezoid*, broad and thin, quadrilateral, stretching between a ridge on the upper surface of the coracoid to an oblique line on the under surface of the clavicle; *nerves*, suprascapular and circumflex; *arteries*, suprascapular, anterior circumflex, acromio-thoracic.

What are the proper ligaments of the scapula?

The *coraco-acromial*[3], a triangular flat band, attached by its apex to the summit of the acromion, by its base all along the outer border of the coracoid process. Its anterior and posterior edges are thick and its center thin. The *superior transverse ligament* bridges the suprascapular notch. It has two bands. The *inferior transverse*, or *spino-glenoid*, is near the base of the spine in the infraspinous fossa. The *glenoid* belongs properly to the scapula, but is described with the shoulder-joint.

Describe the shoulder-joint (Fig. 79).

An *enarthrodial joint* formed by the head of the humerus and glenoid fossa of the scapula. Its synovial membrane is reflected upon the tendons of the biceps and subscapularis, and the joint has numerous bursæ in its vicinity, with some of which it communicates, notably the subcoracoid and subscapular; the ligaments are, *capsular*[5], from the margin of the glenoid fossa above, to the anatomical neck of the humerus below. Strengthening bands are outside and inside the capsule; the former are *coraco-humeral*[6], *transverse humeral ligaments*, and surrounding tendons. Within the joint-cavity are three *gleno-humeral ligaments;* the *upper* one, or *Flood's*, is just below and parallel to the biceps tendon; the *middle* one, or *internal of Schlemm*, is oblique; the *inferior gleno-humeral* is the *inferior* or *broad ligament of Schlemm.*

The *glenoid* is a dense fibro-cartilage, triangular in cross-section, attached to the circumference of the fossa, deepening the socket, and continuous above with the long head of the biceps muscle[7], which really serves as one of the *chief ligaments; nerves*, suprascapular, circumflex, subscapulars; *arteries*, suprascapular, subscapular, dorsalis scapulæ, anterior and posterior circumflex.

Describe the elbow-joint (Fig. 80).

Ginglymoid, formed by the lower end of the humerus, greater and lesser sigmoid cavities of the ulna and head of the radius; its ligaments are:

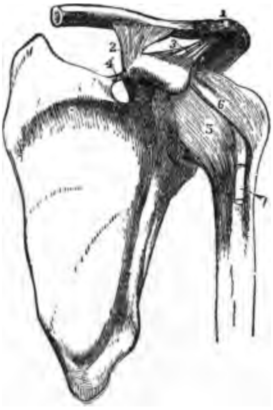


FIG. 79.—Left shoulder-joint and scapular ligaments

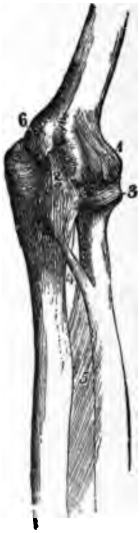


FIG. 80.—Left elbow-joint, antero-internal aspect.

A *capsule*[1], large, capacious, and usually described as showing *anterior*, *posterior*, *internal*, and *external ligaments.*

The *anterior ligament*[1] extends from the humerus, above the articular surface and coronoid fossa, to the front of the coronoid process of the ulna and orbicular ligament.

The *posterior ligament* extends from the back of the humerus, from condyle to condyle, and through the olecranon fossa, to be attached all around the olecranon process, close to its articular margin, a few fibers to the back of the neck of the radius and to the orbicular ligament.

The *external lateral* radiates from the lower part of the condyle to end in the orbicular ligament, sending a few fibers to the neck of the radius and interosseous border of the ulna.

The *internal lateral*[2], triangular, rises from the antero-inferior aspect of the inner epicondyle, and is attached to the inner side of the coronoid and olecranon processes. There are three sets of fibers: *humero-coronoid*, *humero-olecranon*, and (a transverse set) *olecrano-coronoid; nerves*, musculo-cutaneous, ulnar, median, musculo-spiral; *arteries*, the two profunda arteries, anastomotica magna, anterior and posterior ulnar recurrent, posterior interosseous recurrent, radial recurrent, and some muscular branches.

Describe the superior radio-ulnar articulation.

It is a *diarthrosis rotatoria*, or *trochoides*, formed by the head of the radius and lesser sigmoid cavity of the ulna, its synovial membrane being continuous with that of the elbow-joint; its only ligament is the

Orbicular[3], surrounding the head of the radius, forming only four-fifths of a circle by most of its fibers, but some, continued below the sigmoid cavity, form a complete circle; *nerves* and *arteries* as above. This ligament and articulation belong to the elbow-joint.

Describe the inferior radio-ulnar articulation.

A *lateral ginglymus*, formed by the ulnar head and sigmoid cavity of the radius; its synovial membrane is so loose as to be called the *membrana sacciformis;* the ligaments are:

The *triangular fibro-cartilage* attached by its apex to the fossa at the base and to the apex of the styloid process of the ulna, by its base to the margin of the radius below the sigmoid cavity.

The *anterior radio-ulnar* stretches between the anterior edge of the sigmoid cavity of the radius to the rough surface above the articular surface of the ulna.

The *posterior radio-ulnar* is similarly attached behind; *nerves*, anterior interosseous of the median and posterior interosseous of the musculo-spiral; *arteries*, anterior and posterior interosseous and carpal arches.

What other ligaments bind the radius and ulna together?

The *interosseous membrane*[5], passing obliquely downward and inward from the interosseous ridge of the radius to that of the ulna.

The *oblique*[4], attached to the tubercle at the base of the coronoid process of the ulna above, and below to the shaft of the radius a little below its tuberosity; *nerves* and *arteries* are from the anterior interosseous nerve and artery.

Describe the wrist-joint.

It is a *condyloid articulation* with elliptical surfaces. Its motions are flexion and extension, adduction and abduction, a combination of these producing circumduction. It has no rotation; this is accomplished by supination and pronation of the bones of the forearm. It is formed between the radius and triangular fibro-cartilage above, and the scaphoid, semilunar, and cuneiform below; its ligaments are, *capsular*, with four strengthening bands, an *anterior radio-carpal*, passing between the radius, the styloid process of the ulna, and the fibro-cartilage to the first and second rows of the carpal bones.

A *posterior radio-carpal* is similarly disposed, passing from the radius to the first three carpals.

An *internal lateral*, fan-shaped, passing from the styloid process of the ulna to the pisiform, and the side and back of the cuneiform bone.

An *external lateral*, radiating from the tip and front of the styloid process of the radius to the scaphoid, os magnum, and trapezium; the *posterior annular ligament* also assists the wrist-ligaments proper; *nerves*, ulnar, median, and posterior interosseous; *arteries*, anterior and posterior carpal arches, anterior and posterior interosseous.

Describe the carpal articulations.

Arthrodial, they consist of (1) the joints between the bones of the first row; (2) those between the bones of the second; and (3) those between the two rows, the *medio-carpal*.

(1) The *pisiform* has a separate *capsular ligament*, with two bands connecting it with the unciform and base of the fifth metacarpal, and a separate synovial membrane; the other three bones of this row are connected by

Two interosseous ligaments, between the scaphoid and lunar, and the lunar and cuneiform; and

Two dorsal and *two palmar* ligaments, binding together the same bones.

(2) The four bones of the second row have

Two or *three interosseous ligaments*, connecting the os magnum with the trapezoid externally (inconstant), the unciform internally; a third between the trapezium and trapezoid; and

Three dorsal and *three palmar ligaments*, passing between the contiguous bony surfaces.

(3) The two rows are united by the *dorsal and palmar ligaments* and *two lateral*, continuous with those of the wrist-joint; the *anterior annular ligament*, passing from the hook of the unciform and from the pisiform to the trapezium and scaphoid bones, is an important carpal ligament. The *synovial membrane* is common to all the carpal joints, except the *pisiform; nerves*, posterior interosseous, median and ulnar; *arteries*, anterior and posterior carpals of the radial and ulnar, carpal of the anterior interosseous, carpal of the deep palmar arch, and terminal twigs of the anterior and posterior interosseous.

Describe the carpo-metacarpal articulations.

That of the thumb is one of *reciprocal reception*, and enjoys all movements but rotation of the metacarpal on its own axis; it possesses a distinct synovial sac, and its only ligament is the

Capsule attached around the articular surfaces of the trapezium and first metacarpal.

The other four metacarpals from *arthrodial* joints with the adjacent carpal bones, with three *dorsal ligaments* passing from the trapezium, trapezoid, and os magnum to the second bone; *two ligaments* from the os magnum to third; *two ligaments*—one from the magnum, the other from the unciform —to fourth; *one ligament* connecting with the fifth metacarpal and unciform.

One palmar ligament passes from the trapezium to the second metacarpal; *one ligament* each from the trapezium, magnum, and unciform to the third; *one ligament* connects the unciform and fourth bone; *one ligament* passes from the unciform to the fifth metacarpal.

An *interosseous ligament* connects the contiguous inferior angles of the os magnum and unciform with the adjacent surfaces of the third and fourth metacarpal bones; the *synovial membrane* is that common to intercarpal joints, sometimes the joint formed between the fourth and fifth metacarpals and unciform forms a separate synovial sac; *nerves* and *arteries* are the same as those for the medio-carpal joint.

Describe the union of the metacarpal bones with one another.

That of the thumb is isolated; the bases of the others are in contact, forming *arthrodial* joints, lined by prolongations of the synovial sac of the carpus, and are bound together by *palmar*, *dorsal*, and *interosseous ligaments;* the *deep transverse ligament* binds together their heads; it is a part of the palmar fascia.

Describe the metacarpo-phalangeal and interphalangeal articulations.

They are *ginglymo-arthrodial*, connected by *two lateral* ligaments and an *anterior fibro-cartilage*, or *glenoid ligament*, except for the thumb, where this is replaced by two *sesamoid bones*, while behind an expansion of the extensor tendon and some loose areolar tissue completes each little synovial capsule; *nerves* and *arteries* are from the digitals; the *interphalangeal* joints resemble the metacarpo-phalangeal in regard to ligaments; they are true *hinge-joints* (*ginglymus*).

The Articulations of the Lower Extremity.

Describe the hip-joint.

An *enarthrodial*, but not so freely moving joint as that of the shoulder; it is formed by the head of the femur and the acetabulum of the os innominatum; the ligaments are (Fig. 81):

The *capsular*[9], arising near to the acetabular margin, and from the outer surface of the transverse ligament; it is attached to the femur in front to the trochanter major and spiral line, and behind to the neck about half an inch from the posterior intertrochanteric line; it is thence reflected like a tube up to the head of the femur. The capsule has accessory ligaments from the three bones of the os innominatum, *ilio-femoral*, *ilio-trochanteric*, *pubo-femoral*, *ischio-capsular*.

The *ilio-femoral*[8], or *Y-ligament*, arising from the anterior inferior iliac spine to be attached to the spiral line, the outer and inner margins so well marked as to seem like distinct ligamentous bands showing the capsule between.

The *ligamentum teres*[10], arising by separate heads from each side of the cotyloid notch externally, passes beneath the transverse ligament rising from it and the fossa acetabuli covered by the synovial membrane, and is attached to the fossa capitis of the femur.

Cotyloid, a marginal fibro-cartilage attached all around the acetabular margin, forms the transverse ligament below, deepening the socket.

Transverse, is a ligamentous band of the cotyloid bridging the cotyloid notch, converting it into a foramen; *nerves*, from the anterior crural by branch to rectus, obturator, accessory obturator, nerve to the quadratus femoris, great sciatic or lower part of the sacral plexus; *arteries*, internal and external circumflex, obturator, gluteal, and sciatic. The *synovial membrane* commonly communicates with the bursa beneath the ilio-psoas muscle.

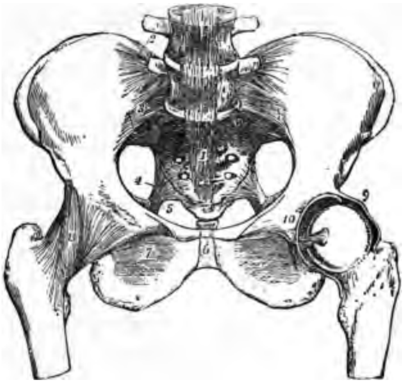


FIG. 81.—Hip-joints, anterior view.

Describe the knee-joint.

Ginglymoid, formed by condyles of the femur, upper surface of the tibial head, and patella, it has the largest *synovial sac* of any joint, sending a prolongation beneath the popliteus muscle and another two or three inches up the front of the femur, beneath the quadriceps tendon, the *subcrural bursa* or *pouch;* the bursa between the semimembranosus and internal head of the gastrocnemius and inner condyle usually communicates with the joint, and often one or more of the remaining bursæ near the articulation; its ligaments consist of

An *anterior* or *ligamentum patellæ*[8] (Fig. 83), a continuation of the quadriceps tendon attached to the tubercle of the tibia below, which, with the fibrous hood formed by the two vasti tendons attached to the patellar margins and the oblique lines on the head of the tibia extending upward from the tubercle, cover in the joint in front blending with the lateral ligaments.

The *posterior* or *ligamentum Winslowii*[8], formed of dense, interlacing fibers, having incorporated with it part of the semimembranosus tendon[7] (Fig. 82), extends from the femur to the tibia and from the external to the internal lateral ligaments. The *popliteal oblique ligament* passes from the back part of the inner tuberosity of the tibia, connected with the semimembranosus upward and outward, within the intercondyloid notch, to the back part of the external condyle of the femur. The *ligamentum arcuatum* is sometimes present below the oblique ligament convex inferiorly.

The *internal lateral*[6], a strong flat band passing from the depression on the inner femoral epicondyle to the inner border and surface of the shaft of the tibia for two or three inches (5–8 cm.) below the articular surface; it is attached to the internal semilunar fibro-cartilage.

The *external lateral ligaments* are two in number:

The *long*[4], a rounded cord attached above to external epicondyle of the femur, below to the outer part of the head of the fibula, splitting the tendon of the biceps;

The *short*, behind and parallel to the above, attached above to the lower part of the outer femoral condyle, below to the summit of the styloid process of the fibula; it joins the arcuate above when that is present. All the preceding ligaments are accessory to and strengthen the

Capsular ligament, within which are the internal ligaments (Fig. 83).

The *anterior crucial*[2], from the inner side of the depression in front of the spine of the tibia, passes upward, backward, and outward to the inner surface of the back part of the outer condyle of the femur.

The *posterior crucial*[3], from back part of the depression behind the tibial spine and popliteal notch to the outer fore part of the inner condyle—both crucial ligaments are attached to the respective extremities of the external semilunar fibrocartilage. The fibers from the external cartilage to the posterior crucial are called the *third crucial* or *ligament of Wrisberg.*

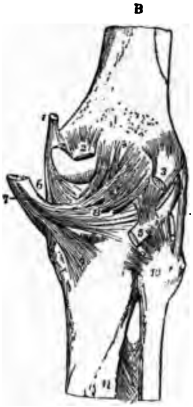


FIG. 82.—Right knee-joint, posterior view. (Leidy.)

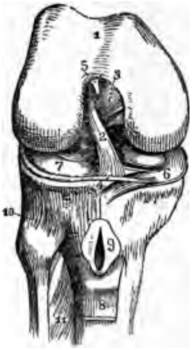


FIG. 83.—Right knee-joint, showing internal ligaments.

Two semilunar fibro-cartilages[6], [7], attached by the extremities to the depressions in front and behind the spine of the tibia; they serve to deepen the sockets for the femoral condyles, and are attached to the head of the tibia by the *coronary ligaments*, short bands passing between their outer margins and the tibial head; they are also connected to one another, in front, by the small band-like *transverse ligament*[4].

Stretching from the front of the joint, below the patella, to the front of the intercondyloid notch, is the triangular fold of the synovial membrane called the *ligamentum mucosum*, from whose sides extend upward and outward to the sides of the patella the fringe-like folds termed *ligamenta alaria.*

Nerves, internal and external popliteal, anterior crural, obturator; *arteries*, five articular from popliteal, anastomotica magna from femoral, two recurrents from anterior tibial, external circumflex, and fourth perforating of profunda. The *bursæ* in relation to the joint are numerous: three prepatellar, three pretibial, one subcrural, four placed externally and five internally.

Describe the superior tibio-fibular articulation.

Arthrodial, formed between the facets on the fibular head and outer tuberosity of the tibia, its ligaments are really a *capsule*, described as

Anterior superior tibio-fibular[10] (Fig. 83), directed obliquely upward and inward from the fibula to the tibia.

Posterior superior tibio-fibular[10] (Fig. 82), similarly disposed behind; the synovial membrane communicates with that of the knee in one out of eighty specimens; *nerves*, from the external popliteal; *arteries*, inferior external articular, anterior and posterior tibial recurrent.

Describe the so-called middle tibio-fibular articulation.

The contiguous borders of the bones are connected by the *interosseous membrane*[11] (Fig. 83), deficient above for the passage of the anterior tibial vessels, below it is perforated by the anterior peroneal vessels; its fibers pass from the tibia downward and outward to the fibula.

Describe the inferior tibio-fibular joint.

Syndesmosis, like a suture, formed superiorly by the rough surfaces of the contiguous bones, below by small cartilage-coated surfaces; its limited synovial membrane is part of that of the ankle.

The ligaments are:

Inferior interosseous, which is really part of the interosseous membrane, passing between the rough surfaces of the two bones.

Anterior and *posterior inferior tibio-fibular*, oblique fibrous bands binding together the contiguous bony surfaces in front and behind.

Transverse, a narrow band passing from the external malleolus to the tibia behind the joint; *nerves*, those of the ankle; *arteries*, anterior and posterior peroneal and external malleolar.

Describe the ankle-joint.

Ginglymoid, formed by the lower end of the tibia with its malleolus and the external malleolus, and the upper surface and sides of the astragalus; its ligaments are the

Anterior[9] (Fig. 84), connecting the articular margins of the tibia and fibula with the rough upper surface of the astragalus.

Posterior[2] (Fig. 84), thin and imperfect, extends between the external malleolus, lower end of the tibia and posterior tibio-fibular ligament above; below, to the posterior surface of the astragalus from one lateral ligament to the other.

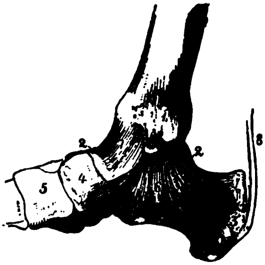


FIG. 84.—Right ankle-joint, internal view.

(Leidy.)

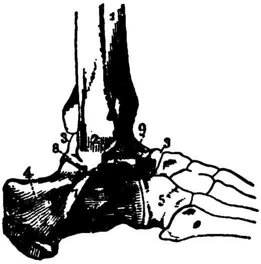


FIG. 85.—Right ankle-joint, external view.

Internal lateral[6] (Fig. 84), (deltoid) radiates from the lower border of the inner malleolus to the astragalus behind, in front to the navicular, and between to the os calcis. It has a deep set of fibers from the malleolus to the astragalus.

External lateral[6,7,8] (Fig. 85), composed of three fasciculi from the anterior margin, apex, and back of the external malleolus; it is attached to the astragalus and the os calcis; *nerves*, internal saphenous, anterior and posterior tibial; *arteries*, anterior and posterior tibial, anterior and posterior peroneal.

Describe the tarsal joints.

Those of the first row are *arthrodial;* the astragalus and calcis have three ligaments:

External calcaneo-astragaloid, from the outer surface of the astragalus to the outer surface of the calcis.

The *posterior calcaneo-astragaloid* connects the posterior tubercle of the astragalus with the upper surface of the calcis.

The *internal calcaneo-astragaloid* connects the back of the astragalus to the sustentaculum tali.

The *interosseous*, the chief bond, filling up the groove on the under surface of the astragalus and upper one of the calcis; there are two synovial sacs, one posterior, the other anterior, continued between the astragalus and navicular; *nerves*, posterior tibial or plantar; *arteries*, posterior tibial, tarsal, external malleolar (from anterior tibial), and terminal twigs of the peroneal.

Joints of the second row, navicular, cuboid, and cuneiforms, have

Dorsal ligaments, small bands connecting the contiguous bones, and

Plantar ligaments, similarly disposed; also four

Interosseous ligaments, connecting the sides of the navicular and cuboid, the internal and middle cuneiform, the middle and external cuneiform, the external cuneiform and cuboid; *nerves*, anterior tibial, internal and external plantar; *arteries*, metatarsal and plantars.

Joints between the two rows, or medio-tarsal: (1) The *calcaneo-cuboid*, *arthrodial*, has

The *superior calcaneo-cuboid ligament*, connecting the dorsal surfaces of the calcis and cuboid.

The *internal* (*interosseous*) *calcaneo-cuboid*, connecting the inner part of the front of the calcis with the postero-internal angle and contiguous part of the cuboid.

The *long calcaneo-cuboid* (*plantar*) arises from the under surface of the calcis between the posterior tubercles and the anterior tubercle, to be attached to the oblique ridge of the cuboid and bases of the second, third, fourth, and fifth metatarsal bones, completing a canal for the long peroneal tendon.

The *short plantar* arises from the anterior calcaneal tubercle and the bone in front, to be attached to the under surface of the cuboid behind the ridge, except at the outer angle; the synovial sac is distinct from that of the other tarsal joints.

(2) The *astragalo-navicular articulation* is the only *enarthrodial* (ball-and-socket) joint of the tarsus; its only ligament is the *superior astragalo-navicular*.

The ligaments connecting the os calcis and navicular are

The *superior calcaneo-navicular*, dense and thick, extending from the anterior internal extremity of the calcis to the outer surface of the navicular.

The *inferior calcaneo-navicular*, passing obliquely forward from the sustentaculum tali to the under surface of the navicular; *nerves* of the medio-tarsal joint are the external branch of the anterior tibial, sometimes the musculo-cutaneous or external plantar; *arteries*, anterior tibial, tarsal, metatarsal, external, and internal plantar.

Describe the tarso-metatarsal articulations.

Arthrodial, between the three cuneiforms and the cuboid, and the bases of the five metatarsals; their ligaments are:

Dorsal, one between the first metatarsal and internal cuneiform; one from each cuneiform to the second; one each from the external cuneiform to the third and fourth; one each from the cuboid to the fourth and fifth metatarsals.

Plantar, more irregularly disposed ligamentous fibers.

Interosseous, one connecting the outer extremity of the inner cuneiform to the adjacent angle of the second metatarsal; one between the outer cuneiform and the adjacent angle of the second metatarsal; one connecting the outer angle of the external cuneiform with side of the third metatarsal; *nerves*, anterior tibial and plantars; *arteries*, from the dorsalis pedis by the metatarsal, deep plantar arch, and internal plantar.

Describe the articulations of the metatarsal bones with each other.

Except the first, their bases are bound together by the *dorsal*, *plantar*, and *interosseous* ligaments; the distal extremities are united by the *deep transverse metatarsal ligament.*

Describe the metatarso-phalangeal and the interphalangeal articulations.

They resemble in all respects those of the hand (which see).

How many distinct synovial sacs have the tarsus and the metatarsus?

Six, viz.: (1) between the calcis and the astragalus, posterior to the interosseous ligament; (2) in front of the same ligament, between the calcis and the astragalus, also between the astragalus and navicular; (3) between the calcis and the cuboid; (4) between the navicular, cuboid, and the cuneiforms, communicating between the middle and the external cuneiforms with the joints formed between those bones and the bases of the second and third metatarsals; (5) between the sides and bases of the fourth and fifth metatarsals and the cuboid; (6) between the base of the first metatarsal and the internal cuneiform.

MUSCLES AND FASCIÆ.

What is a muscle?

It is a structure connected with bones, cartilages, ligaments, or skin, directly or through the medium of a tendon or aponeurosis; the structure is capable of shortening when irritated mechanically or by nerve-stimulus, this property being called *muscular contractility* or *irritability.*

How are muscles divided?

According to their form, into narrow, broad, penniform (when their fibers converge like the plumes of a pen to *one* side of the tendon); *bipenniform* when so arranged on both sides of a tendon, radiated; also named from situation, direction, use, size, or attachments.

What are the varieties of muscular tissue?

There are *two*, one variety consisting of prismatic fasciculi about $\frac{1}{400}$th of an inch in diameter, marked by transverse striæ, each bundle surrounded by a sheath or *perimysium;* each fasciculus is formed of a number of *fibrillæ*, $\frac{1}{18000}$th of an inch in diameter, surrounded by a tubular, transparent elastic membranous *sarcolemma.* Every fibril presents alternating dark and light zones; the former is the *transverse disk;* in its center is a transverse lighter band, *Hensen's line.* The light zone is divided into two *lateral disks* by a dark line called the *intermediate disk*, or *Krause's membrane.* A *sarcous element* of Bowman is the part included between two lines of Krause. This variety of tissue forms the *voluntary*, *striped muscles*, or those of *animal life*, being under the control of the will; the *involuntary*, *unstriped*, or the muscles of *organic life*, are not under the control of the will, and consist of elongated, spindle-shaped, flattened, nucleated cells, $\frac{1}{600}$th to $\frac{1}{300}$th of an inch long, $\frac{1}{4500}$th to $\frac{1}{3500}$th broad, and are held together in bundles by a cement-substance containing a few connective-tissue corpuscles, the bundles being further collected into larger fasciculi, or flattened bands, bound together by ordinary areolar tissue; this kind of muscle is that found forming the contractile coats of the stomach, intestines, bladder, arteries, veins, lymphatics, ureters, urethra, iris, ciliary body, etc.; when irritated a part contracts and slowly relaxes, while another contiguous portion is contracting, which action being continued produces the *vermicular* (worm-like), peristaltic movements of the intestines. The spontaneously coagulable albuminous substance composing muscle is called *myosin;* so-called *syntonin* is a modification produced by chemical agents.

What are tendons and aponeuroses?

Tendons are glistening cords or bands, of white inelastic fibrous tissue, almost without blood- or nerve-supply, and connect the muscular tissue with the part to be moved; *aponeuroses* are membranous expansions of the same tissue serving similar purposes.

What are the fasciæ?

They are laminæ of fibrous or fibro-areolar tissue investing the soft tissues; the superficial fasciæ are usually fibro-areolar, lie beneath the skin, and are loaded with fat; the deep fasciæ resemble aponeuroses, are dense and inelastic, ensheathing muscles, or serving for their attachment, and tend to preserve the form of the part, since partitions descend between various muscles to become attached to the periosteum of the osseous framework.

To what are the tendons attached?

To the periosteum and perichondrium with which they become blended, to the subcutaneous tissue, and to ligaments.

What are meant by the origin and the insertion of a muscle?

The *origin* is the most fixed and central point from which the muscle acts; the *insertion* is the movable point to which the muscular force is directed; but in many muscular acts the part usually described as the *insertion* becomes the fixed point, and the origin the movable one. Some muscles have double origins and single insertions, as the occipito-frontalis, digastric, or omo-hyoid.

Muscles of the Head.

Describe the origin, insertion, action, and nerve-supply of the following muscles (Fig. 86).

The facial nerve supplies motion to all the muscles of expression; the inferior maxillary division of the fifth, to all muscles of mastication except the buccinator.

Occipito-frontalis[1]: *origin*, *occipital portion*, outer two-thirds of the superior curved line of the occipital bone and mastoid process, *insertion* into the epicranial aponeurosis; *frontal portion* rises from the epicranial aponeurosis and blends below with the eyebrow, continuous with the pyramidalis nasi, interlacing with the corrugator supercilii and orbicularis palpebrarum; *action*, raises the eyebrows and transversely wrinkles forehead; *nerves*, facial, by its posterior auricular and temporal branches.

Attolens aurem[4]: *origin*, epicranial aponeurosis; *insertion*, superior portion of the pinna of the ear; *action*, raises the pinna; *nerve*, temporal branch of the facial.

Atrahens aurem: *origin*, lateral margin of the epicranial aponeurosis; *insertion*, a projection on front of the helix; *action*, draws the pinna forward and upward; *nerve*, facial.

Retrahens aurem[5]: *origin*, mastoid portion of the temporal bone; *insertion*, lower part of the concha; *action*, draws ear backward; *nerve*, posterior auricular branch of the facial.

Orbicularis palpebrarum[6]: *origin*, internal angular process of the frontal, nasal process of the superior maxillary bone, and the anterior surface and margins of the tarsal ligaments; *insertion*, skin of the eyelids and contiguous portions of the forehead, temple, and cheek, blending with the occipito-frontalis and corrugator supercilii muscles; *action*, closes eyelids; *nerve*, facial.

Corrugator supercilii: *origin*, inner end of the superciliary ridge; *insertion*, upward and outward to the under surface of the orbicularis palpebrarum; *action*, draws the eyebrow downward and inward; *nerve*, facial.

Tensor tarsi (Horner's muscle): *origin*, crest of the lacrimal bone; *insertion*, by two slips into the tarsal cartilages near the puncta; *action*, compresses the lacrimal sac and keeps the puncta in contact with the globe; *nerve*, facial. (For occular muscles, see p. 355.)

Levator palpebræ superioris[8]: *origin*, lesser wing of the sphenoid; *insertion*, upper border of the superior tarsal cartilage and into the skin; *action*, elevates the upper lid; *nerve*, third cranial (motor oculi).

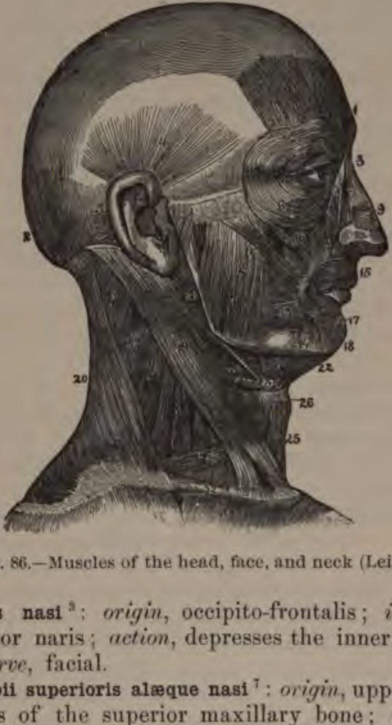


FIG. 86.—Muscles of the head, face, and neck (Leidy).

Pyramidalis nasi[3]: *origin*, occipito-frontalis; *insertion*, into the compressor naris; *action*, depresses the inner angle of the eyebrow; *nerve*, facial.

Levator labii superioris alæque nasi[7]: *origin*, upper part of the nasal process of the superior maxillary bone; *insertion*, the cartilage of the ala of the nose, and into the upper lip blending with the orbicularis and levator labii; *action*, draws upward the upper lip and dilates the nostril; *nerve*, facial.

Dilator naris anterior: *origin*, cartilage of the ala; *insertion*, integument near its margin; *action*, dilates the nostril; *nerve*, facial.

Dilator naris posterior: *origin*, margin of the nasal notch of the superior maxilla and the sesamoid cartilages; *insertion*, skin near the margin of the nostril; *action*, dilates the nostril; *nerve*, facial.

Compressor nasi[9]: *origin*, above and external to the incisive fossa of the superior maxilla; *insertion*, fibro-cartilage of the nose, and is continuous with its fellow and the aponeurosis of the pyramidalis nasi; *action*, depresses cartilage, compresses alæ, dilates nostril, and wrinkles skin; *nerve*, facial.

Compressor narium minor: *origin*, alar cartilage; *insertion*, skin of tip of the nose; *action*, dilates the nostril; *nerve*, facial.

Depressor alæ nasi: *origin*, incisive fossa of the superior maxilla; *insertion*, septum and back part of the ala; *action*, narrows the nostril; *nerve*, facial.

Levator labii superioris[8]: *origin*, lower margin of the orbit above the infraorbital foramen; *insertion*, muscular substance of the upper lip; *action*, elevates the lip; *nerve*, facial.

Levator anguli oris[16]: *origin*, canine fossa of the superior maxilla; *insertion*, angle of the mouth; *action*, elevates angle of the mouth; *nerve*, facial.

Zygomaticus major[11]: *origin*, malar bone; *insertion*, angle of the mouth; *action*, elevates angle of the lip; *nerve*, facial.

Zygomaticus minor[10] (inconstant): *origin*, malar bone anteriorly; *insertion*, angle of the mouth; *action*, same as major; *nerve*, facial.

Levator labii inferioris (levator menti): *origin*, incisive fossa of the lower jaw; *insertion*, skin of the chin; *action*, elevates the chin and the lower lip; *nerve*, facial.

Depressor labii inferioris[17-18] **(quadratus menti)**: *origin*, external oblique line of the lower jaw; *insertion*, skin of the lower lip; *action*, depresses the lower lip; *nerve*, facial.

Depressor anguli oris[14]: *origin*, external oblique line of the lower jaw; *insertion*, angle of the mouth; *action*, depresses angle of the mouth; *nerve*, facial.

Orbicularis oris[15]: *origin*, nasal septum and superior and inferior maxillary borders by accessory fibers called *accessorii orbicularis superioris* and *inferioris*, and *naso-labialis*; *insertion*, the buccinator and other muscles converging to the mouth; *action*, closes the mouth; *nerve*, facial.

Buccinator[13]: *origin*, behind, from the pterygo-maxillary ligament, above and below the external surfaces of the alveolar processes of the three molar teeth; *insertion*, orbicularis oris;

action, compresses the cheek; *nerve*, facial and buccal branch of the inferior maxillary, the latter being sensory.

Risorius (Santorini): *origin*, fascia over the masseter muscle; *insertion*, skin at angle of the mouth; *action*, laughing muscle; *nerve*, facial.

Masseter[12]: *origin*, the superficial portion from the malar process of the superior maxilla and the anterior two-thirds of the lower border of the zygomatic arch, the deep portion from the posterior third of the lower border and the inner surface of the zygomatic arch; *insertion*, into the outer surface of the ramus, angle, and coronoid process of the lower jaw; *action*, raises, protracts, and retracts the lower jaw, a masticatory muscle; *nerve*, inferior maxillary.

Temporal: *origin*, temporal fossa and fascia; *insertion*, into anterior border, apex, and inner surface of the coronoid process of the lower jaw; *action*, raises and retracts the lower jaw, a muscle of mastication; *nerve*, inferior maxillary.

Internal pterygoid: *origin*, by two heads from the inner surface of the external pterygoid plate and grooved surface of the palate bone, and by a second slip from the tuberosity of the palate and superior maxillary bones; *insertion*, lower back part of the inner side of the ramus and angle of the jaw as high as the dental foramen; *action*, raises and draws the lower jaw forward, a muscle of mastication; *nerve*, inferior maxillary.

External pterygoid: *origin*, by two heads, one from the infratemporal ridge on the greater wing of the sphenoid, and from the bone included between it and the base of the pterygoid process, the other from the outer surface of the external pterygoid plate; *insertion*, depression in front of the neck of the condyle of the lower jaw and interarticular fibro-cartilage; *action*, depresses and draws the jaw forward, a triturating masticatory muscle; *nerve*, inferior maxillary. Usually the internal maxillary artery passes between the two heads of this muscle: sometimes pierces it; often lies below it.

Muscles of the Neck.

Platysma myoides: *origin*, deep fascia over the pectoral, deltoid, sterno-mastoid, and trapezius muscles; *insertion*, lower jaw beneath the oblique line, angle of the mouth, cellular tissue, and some muscles of the face; *action*, wrinkles skin of the neck and depresses the jaw and angle of the mouth; *nerves*, facial, by the inframaxillary branches.

Sterno-cleido-mastoid[11] (Fig. 87): *origin*, upper front part of the sternum, inner third of upper border of the clavicle; *insertion*, mastoid process of the temporal and outer two-thirds of the superior curved line of the occipital bone; *action*, acting *singly*, flexes head sideways, and rotates chin to the opposite side, *both* acting flex the head on the neck, and the neck on the chest; *nerves*, spinal accessory, second and third cervical nerves, anterior branches.

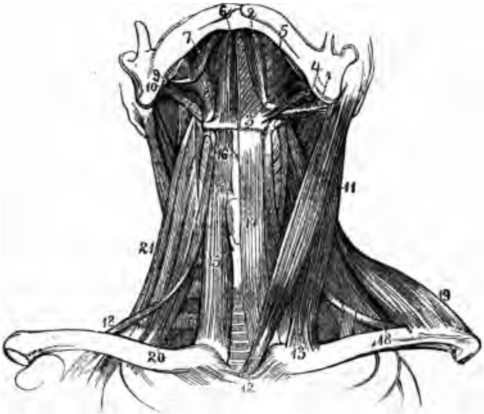


FIG. 87.—Muscles of the neck, anterior view (Leidy).

Sterno-hyoid[14]: *origin*, ribbon-like, from the posterior surface of the sternum and inner end of the clavicle; *insertion*, body of the hyoid bone; *action*, depresses the hyoid bone; *nerves*, filaments from the loop between the descendens and the communicans cervicalis.

Sterno-thyroid[15]: *origin*, posterior surface of the sternum and cartilage of the first rib, sometimes from the clavicle; *insertion*, oblique line on the ala of the thyroid cartilage; *action*, depresses the larynx; *nerves*, same as the sterno-hyoid.

Thyro-hyoid[16]: *origin*, oblique line of the thyroid cartilage; *insertion*, lower border of the body and greater cornu of the hyoid bone; *action*, may elevate the larynx or depress the hyoid; *nerve*, descendens cervicalis.

Omo-hyoid[18]: *origin*, from the upper border of the scapula near the suprascapular notch, perhaps, also, from the transverse ligament; *insertion*, body of the hyoid bone, its *central tendinous portion* being held down by a process of the deep cervical fascia prolonged down to be attached to the cartilage of the first rib; *action*, depresses the hyoid bone and larynx, and draws them backward to one or the other side; *nerves*, from the loop between the descendens and the communicans cervicalis.

Digastric[1, 2]: *origin*, has two fleshy bellies with an intermediate rounded tendon, the posterior[1] is attached to the digastric groove of the mastoid process of the temporal, the anterior[2] to the depression on the inner side of the lower border of the jaw near the symphysis; *insertion*, tendon perforates the stylo-hyoid, and is held to the side of the body and greater cornu of the hyoid bone by an aponeurotic loop lined with synovial membrane; *action*, raises the hyoid bone; if this be fixed by its muscles, depresses the lower jaw; *nerves*, posterior belly by the facial, anterior by the mylo-hyoid branch of the inferior dental.

Stylo-hyoid[4]: *origin*, middle of the outer surface of the styloid process of the temporal; *insertion*, body of the hyoid at its junction with the greater cornu; it is perforated by the digastric tendon; *action*, same as the posterior belly of the digastric; *nerve*, facial.

Mylo-hyoid[5]: *origin*, mylo-hyoid ridge of the lower jaw; *insertion*, body of the hyoid bone and median raphé; *action*, same as the digastric and stylo-hyoid; *nerve*, mylo-hyoid branch of the inferior dental; it forms with its fellow the muscular floor of the mouth.

Genio-hyoid[6]: *origin*, inferior genial tubercle of the lower jaw; *insertion*, body of the hyoid bone; *action*, same as the digastric; *nerve*, descendens cervicalis.

Genio-hyo-glossus[7]: *origin*, superior genial tubercle of the lower jaw; *insertion*, body of the hyoid bone, side of the pharynx, and tongue from the base to apex; *action*, protrudes the tongue by the posterior and inferior fibers, retracts it by the anterior fibers, both muscles acting render tongue concave from side to side, as in sucking; *nerve*, hypoglossal.

Hyo-glossus[8]: *origin*, body, lesser, and whole length of the greater cornu of the hyoid bone; *insertion*, side of the tongue; the parts may be called *basio-*, *chondro-*, and *kerato-glossus; action*, draws down the sides of the tongue, making it convex; *nerve*, hypoglossal.

Stylo-glossus[9]: *origin*, near the center of the antero-external surface of the styloid process and stylo-maxillary ligament; *insertion*, side of the tongue and hyo-glossus muscle; *action*, draws the tongue upward and backward; *nerve*, hypoglossal.

Lingualis forms the bulk of the tongue lying between the hyo-glossus and genio-hyo-glossus on each side; it has four sets of fibers, *superior*, *inferior*, *transverse*, and *vertical lingualis.*

Palatal Region.

Levator palati: *origin*, under surface of the apex of the petrous portion of the temporal bone and contiguous portion of the cartilaginous Eustachian tube; *insertion*, into the posterior surface of the soft palate; *action*, elevates the soft palate; *nerve* was said to be facial; it is probably the spinal accessory through the pharyngeal plexus.

Tensor palati: *origin*, scaphoid fossa, outer side of the Eustachian tube, spine of the sphenoid, edge of the tympanic plate: *insertion*, after reflection around the hamular process, into the forepart of the aponeurosis of the soft palate and the under surface of the palate bone; *action*, renders the soft palate tense; *nerve*, branch from the otic ganglion.

Azygos uvulæ: *origin*, posterior nasal spine and palatal aponeurosis; *insertion*, uvula; *action*, raises the uvula; *nerve*, same as for the levator palati; it is not a *single* muscle, as the name implies.

Palato-glossus (anterior pillar of fauces): *origin*, anterior surface of the soft palate external to the uvula; *insertion*, side and dorsum of the tongue; *action*, as one of its names implies, constrictor isthmi faucium; *nerve*, spinal accessory through the pharyngeal plexus.

Palato-pharyngeus (posterior pillar of fauces): *origin*, soft palate; *insertion*, posterior border of the thyroid cartilage and side of the pharynx; *action*, closes the posterior fauces; *nerve*, same as for the palato-glossus.

Vertebral Region.

Rectus capitis anticus major: *origin*, by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *insertion*, basilar process of the occipital bone; *action*, flexes the head and slightly rotates; *nerves*, suboccipital, and from a loop formed by it and the second cervical.

Rectus capitis anticus minor : *origin*, front of the lateral mass of the atlas and root of its transverse process; *insertion*, basilar process of the occipital bone behind the preceding muscle; *action*, flexes the head; *nerve*, suboccipital.

Rectus lateralis: *origin*, upper surface of the transverse process of the atlas; *insertion*, jugular process of the occipital bone; *action*, draws the head laterally when one acts, flexes when both act; *nerve*, suboccipital. These muscles belong to the series of intertransverse muscles.

Longus colli: *origin*, *superior oblique portion* from the anterior transverse tubercles of the third, fourth, and fifth cervical vertebræ; *insertion*, tubercle on the anterior arch of the atlas; the *inferior oblique portion arises* from the bodies of the first two or three thoracic vertebræ, *insertion*, transverse processes of the fifth and sixth cervical vertebræ; *vertical portion* extends between the bodies of the three upper thoracic and three lower cervical, and those of the second, third, and fourth cervical vertebræ; *action*, flexes and slightly rotates the cervical spine; *nerves*, anterior branches from the lower cervical nerves.

Scalenus anticus[20] (Fig. 87): *origin*, anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *insertion*, tubercle on the upper surface of the first rib; *action*, lateral flexion of the cervical spine or elevation of the ribs; *nerves*, anterior branches of the fourth, fifth, and sixth cervical nerves before the plexus is made.

Scalenus medius[21]: *origin*, posterior tubercles of the transverse processes of the six lower cervical vertebræ; *insertion*, upper surface of the first rib behind the subclavian groove; *action*, similar to the preceding; *nerves*, anterior branches from the cervical.

Scalenus posticus: *origin*, posterior tubercles of the two or three lower cervical vertebræ; *insertion*, outer surface of the second rib; *action*, flexes neck laterally, or elevates the second rib; *nerves*, anterior branches from the three lower cervical.

Muscles of the Back.

First layer (Fig. 88):

Trapezius [1]: *origin*, inner third of the superior curved line of the occipital bone, ligamentum nuchæ, spinous processes of the seventh cervical and of all the thoracic vertebræ, and corresponding portion of the supraspinous ligament; *insertion*, outer third of the posterior border and upper surface of the clavicle, inner margin of the acromion process, the superior lip of the crest of the spine of scapula, and the tubercle at its inner extremity; *action*, one acting draws the head to its own side, both acting draw the head backward, and with the head fixed elevate the point of the shoulder; middle and lower fibers partially rotate the scapula on the chest; *nerves*, spinal accessory, third and fourth cervical from anterior divisions.

Ligamentum nuchæ (a thin band of condensed cellulo-fibrous membrane): *origin*, external occipital protuberance; *insertion*, spinous processes of all the cervical vertebræ except the atlas; a rudiment of a strong elastic ligament sustaining the head in the lower animals.

Latissimus dorsi [4]: *origin*, by an aponeurosis from the spinous processes of the six lower thoracic vertebræ, those of the lumbar and sacral vertebræ and supraspinous ligament, also external lip of the iliac crest behind the external oblique, from the three or four lower ribs, and often from the inferior angle of the scapula; *insertion*, floor of the bicipital groove of the humerus; *action*, draws the humerus downward and backward while rotating inward; with fixed arms, raises the lower ribs in forcible inspiration, assists the greater pectorals and the abdominal muscles in drawing the trunk forward, as when climbing, or using crutches, etc.; *nerve*, long subscapular nerve.

Second layer:

Levator scapulæ [10]: *origin*, by three or four tendinous slips from the posterior tubercles of the transverse processes of the three or four upper cervical vertebræ; *insertion*, posterior border of the scapula between the superior angle and triangular surface at the apex of the spine; *action*, raises the scapular angle, extensor and lateral flexor of the neck; *nerves*, from the anterior divisions of the third, fourth, and fifth cervical.

Rhomboideus minor[11]: *origin*, ligamentum nuchæ, and spinous processes of the seventh cervical and first thoracic vertebræ; *insertion*, margin of the triangular surface at the apex of the spine of the scapula; *action*, draws the inferior angle backward and upward; *nerve*, fifth cervical.

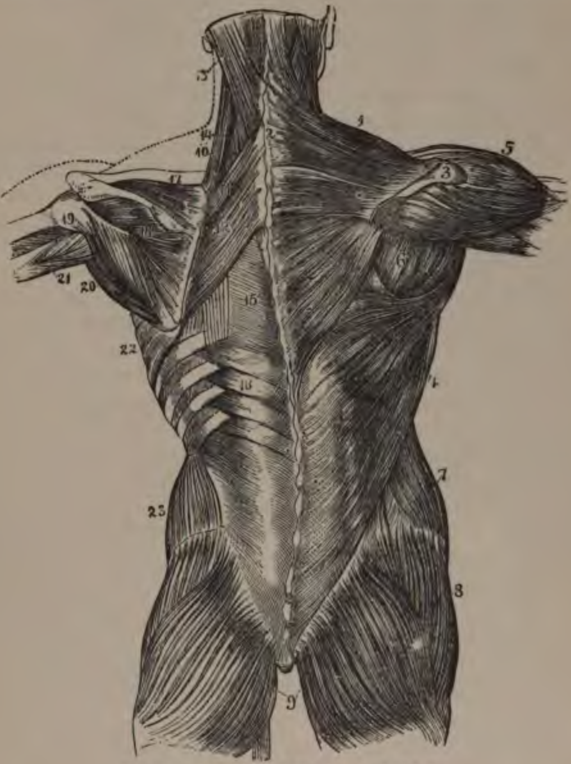


FIG. 88.—Muscles of the back (Leidy).

Rhomboideus major[12]: *origin*, spinous processes of the four or skin near the margin of the nostril; *action*, dilates the nostril; *nerve*, facial.

Compressor nasi[9]: *origin*, above and external to the incisive fossa of the superior maxilla; *insertion*, fibro-cartilage of the nose, and is continuous with its fellow and the aponeurosis of the pyramidalis nasi; *action*, depresses cartilage, compresses alæ, dilates nostril, and wrinkles skin; *nerve*, facial.

Compressor narium minor: *origin*, alar cartilage; *insertion*, skin of tip of the nose; *action*, dilates the nostril; *nerve*, facial.

Depressor alæ nasi: *origin*, incisive fossa of the superior maxilla; *insertion*, septum and back part of the ala; *action*, narrows the nostril; *nerve*, facial.

Levator labii superioris[8]: *origin*, lower margin of the orbit above the infraorbital foramen; *insertion*, muscular substance of the upper lip; *action*, elevates the lip; *nerve*, facial.

Levator anguli oris[16]: *origin*, canine fossa of the superior maxilla; *insertion*, angle of the mouth; *action*, elevates angle of the mouth; *nerve*, facial.

Zygomaticus major[11]: *origin*, malar bone; *insertion*, angle of the mouth; *action*, elevates angle of the lip; *nerve*, facial.

Zygomaticus minor[10] (inconstant): *origin*, malar bone anteriorly; *insertion*, angle of the mouth; *action*, same as major; *nerve*, facial.

Levator labii inferioris (levator menti): *origin*, incisive fossa of the lower jaw; *insertion*, skin of the chin; *action*, elevates the chin and the lower lip; *nerve*, facial.

Depressor labii inferioris[17-18] **(quadratus menti)**: *origin*, external oblique line of the lower jaw; *insertion*, skin of the lower lip; *action*, depresses the lower lip; *nerve*, facial.

Depressor anguli oris[14]: *origin*, external oblique line of the lower jaw; *insertion*, angle of the mouth; *action*, depresses angle of the mouth; *nerve*, facial.

Orbicularis oris[15]: *origin*, nasal septum and superior and inferior maxillary borders by accessory fibers called *accessorii orbicularis superioris* and *inferioris*, and *naso-labialis; insertion*, the buccinator and other muscles converging to the mouth; *action*, closes the mouth; *nerve*, facial.

Buccinator[13]: *origin*, behind, from the pterygo-maxillary ligament, above and below the external surfaces of the alveolar processes of the three molar teeth; *insertion*, orbicularis oris;

action, compresses the cheek; *nerve*, facial and buccal branch of the inferior maxillary, the latter being sensory.

Risorius (Santorini): *origin*, fascia over the masseter muscle; *insertion*, skin at angle of the mouth; *action*, laughing muscle; *nerve*, facial.

Masseter[12]: *origin*, the superficial portion from the malar process of the superior maxilla and the anterior two-thirds of the lower border of the zygomatic arch, the deep portion from the posterior third of the lower border and the inner surface of the zygomatic arch; *insertion*, into the outer surface of the ramus, angle, and coronoid process of the lower jaw; *action*, raises, protracts, and retracts the lower jaw, a masticatory muscle; *nerve*, inferior maxillary.

Temporal: *origin*, temporal fossa and fascia; *insertion*, into anterior border, apex, and inner surface of the coronoid process of the lower jaw; *action*, raises and retracts the lower jaw, a muscle of mastication; *nerve*, inferior maxillary.

Internal pterygoid: *origin*, by two heads from the inner surface of the external pterygoid plate and grooved surface of the palate bone, and by a second slip from the tuberosity of the palate and superior maxillary bones; *insertion*, lower back part of the inner side of the ramus and angle of the jaw as high as the dental foramen; *action*, raises and draws the lower jaw forward, a muscle of mastication; *nerve*, inferior maxillary.

External pterygoid: *origin*, by two heads, one from the infratemporal ridge on the greater wing of the sphenoid, and from the bone included between it and the base of the pterygoid process, the other from the outer surface of the external pterygoid plate; *insertion*, depression in front of the neck of the condyle of the lower jaw and interarticular fibro-cartilage; *action*, depresses and draws the jaw forward, a triturating masticatory muscle; *nerve*, inferior maxillary. Usually the internal maxillary artery passes between the two heads of this muscle: sometimes pierces it; often lies below it.

Muscles of the Neck.

Platysma myoides: *origin*, deep fascia over the pectoral, deltoid, sterno-mastoid, and trapezius muscles; *insertion*, lower jaw beneath the oblique line, angle of the mouth, cellular tissue, and some muscles of the face; *action*, wrinkles skin of the neck and depresses the jaw and angle of the mouth; *nerves*, facial, by the inframaxillary branches.

Sterno-cleido-mastoid[11] (Fig. 87): *origin*, upper front part of the sternum, inner third of upper border of the clavicle; *insertion*, mastoid process of the temporal and outer two-thirds of the superior curved line of the occipital bone; *action*, acting *singly*, flexes head sideways, and rotates chin to the opposite side, *both* acting flex the head on the neck, and the neck on the chest; *nerves*, spinal accessory, second and third cervical nerves, anterior branches.

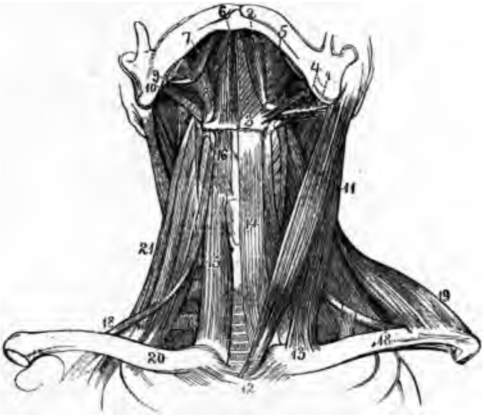


FIG. 87.—Muscles of the neck, anterior view (Leidy).

Sterno-hyoid[14]: *origin*, ribbon-like, from the posterior surface of the sternum and inner end of the clavicle; *insertion*, body of the hyoid bone; *action*, depresses the hyoid bone; *nerves*, filaments from the loop between the descendens and the communicans cervicalis.

Sterno-thyroid[15]: *origin*, posterior surface of the sternum and cartilage of the first rib, sometimes from the clavicle; *insertion*, oblique line on the ala of the thyroid cartilage; *action*, depresses the larynx; *nerves*, same as the sterno-hyoid.

Thyro-hyoid[16]: *origin*, oblique line of the thyroid cartilage; *insertion*, lower border of the body and greater cornu of the hyoid bone; *action*, may elevate the larynx or depress the hyoid; *nerve*, descendens cervicalis.

Omo-hyoid[18]: *origin*, from the upper border of the scapula near the suprascapular notch, perhaps, also, from the transverse ligament; *insertion*, body of the hyoid bone, its *central tendinous portion* being held down by a process of the deep cervical fascia prolonged down to be attached to the cartilage of the first rib; *action*, depresses the hyoid bone and larynx, and draws them backward to one or the other side; *nerves*, from the loop between the descendens and the communicans cervicalis.

Digastric[1, 2]: *origin*, has two fleshy bellies with an intermediate rounded tendon, the posterior[1] is attached to the digastric groove of the mastoid process of the temporal, the anterior[2] to the depression on the inner side of the lower border of the jaw near the symphysis; *insertion*, tendon perforates the stylo-hyoid, and is held to the side of the body and greater cornu of the hyoid bone by an aponeurotic loop lined with synovial membrane; *action*, raises the hyoid bone; if this be fixed by its muscles, depresses the lower jaw; *nerves*, posterior belly by the facial, anterior by the mylo-hyoid branch of the inferior dental.

Stylo-hyoid[4]: *origin*, middle of the outer surface of the styloid process of the temporal; *insertion*, body of the hyoid at its junction with the greater cornu; it is perforated by the digastric tendon; *action*, same as the posterior belly of the digastric; *nerve*, facial.

Mylo-hyoid[5]: *origin*, mylo-hyoid ridge of the lower jaw; *insertion*, body of the hyoid bone and median raphé; *action*, same as the digastric and stylo-hyoid; *nerve*, mylo-hyoid branch of the inferior dental; it forms with its fellow the muscular floor of the mouth.

Genio-hyoid[6]: *origin*, inferior genial tubercle of the lower jaw; *insertion*, body of the hyoid bone; *action*, same as the digastric; *nerve*, descendens cervicalis.

Genio-hyo-glossus[7]: *origin*, superior genial tubercle of the lower jaw; *insertion*, body of the hyoid bone, side of the pharynx, and tongue from the base to apex; *action*, protrudes the tongue by the posterior and inferior fibers, retracts it by the anterior fibers, both muscles acting render tongue concave from side to side, as in sucking; *nerve*, hypoglossal.

Hyo-glossus[8]: *origin*, body, lesser, and whole length of the greater cornu of the hyoid bone; *insertion*, side of the tongue; the parts may be called *basio-*, *chondro-*, and *kerato-glossus; action*, draws down the sides of the tongue, making it convex; *nerve*, hypoglossal.

Stylo-glossus[9]: *origin*, near the center of the antero-external surface of the styloid process and stylo-maxillary ligament; *insertion*, side of the tongue and hyo-glossus muscle; *action*, draws the tongue upward and backward; *nerve*, hypoglossal.

Lingualis forms the bulk of the tongue lying between the hyo-glossus and genio-hyo-glossus on each side; it has four sets of fibers, *superior*, *inferior*, *transverse*, and *vertical lingualis.*

Palatal Region.

Levator palati: *origin*, under surface of the apex of the petrous portion of the temporal bone and contiguous portion of the cartilaginous Eustachian tube; *insertion*, into the posterior surface of the soft palate; *action*, elevates the soft palate; *nerve* was said to be facial; it is probably the spinal accessory through the pharyngeal plexus.

Tensor palati: *origin*, scaphoid fossa, outer side of the Eustachian tube, spine of the sphenoid, edge of the tympanic plate: *insertion*, after reflection around the hamular process, into the forepart of the aponeurosis of the soft palate and the under surface of the palate bone; *action*, renders the soft palate tense; *nerve*, branch from the otic ganglion.

Azygos uvulæ: *origin*, posterior nasal spine and palatal aponeurosis; *insertion*, uvula; *action*, raises the uvula; *nerve*, same as for the levator palati; it is not a *single* muscle, as the name implies.

Palato-glossus (anterior pillar of fauces): *origin*, anterior surface of the soft palate external to the uvula; *insertion*, side and dorsum of the tongue; *action*, as one of its names implies, constrictor isthmi faucium; *nerve*, spinal accessory through the pharyngeal plexus.

Palato-pharyngeus (posterior pillar of fauces): *origin*, soft palate; *insertion*, posterior border of the thyroid cartilage and side of the pharynx; *action*, closes the posterior fauces; *nerve*, same as for the palato-glossus.

Vertebral Region.

Rectus capitis anticus major: *origin*, by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *insertion*, basilar process of the occipital bone; *action*, flexes the head and slightly rotates; *nerves*, suboccipital, and from a loop formed by it and the second cervical.

Rectus capitis anticus minor: *origin*, front of the lateral mass of the atlas and root of its transverse process; *insertion*, basilar process of the occipital bone behind the preceding muscle; *action*, flexes the head; *nerve*, suboccipital.

Rectus lateralis: *origin*, upper surface of the transverse process of the atlas; *insertion*, jugular process of the occipital bone; *action*, draws the head laterally when one acts, flexes when both act; *nerve*, suboccipital. These muscles belong to the series of intertransverse muscles.

Longus colli: *origin*, *superior oblique portion* from the anterior transverse tubercles of the third, fourth, and fifth cervical vertebræ; *insertion*, tubercle on the anterior arch of the atlas; the *inferior oblique portion arises* from the bodies of the first two or three thoracic vertebræ, *insertion*, transverse processes of the fifth and sixth cervical vertebræ; *vertical portion* extends between the bodies of the three upper thoracic and three lower cervical, and those of the second, third, and fourth cervical vertebræ; *action*, flexes and slightly rotates the cervical spine; *nerves*, anterior branches from the lower cervical nerves.

Scalenus anticus[20] (Fig. 87): *origin*, anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *insertion*, tubercle on the upper surface of the first rib; *action*, lateral flexion of the cervical spine or elevation of the ribs; *nerves*, anterior branches of the fourth, fifth, and sixth cervical nerves before the plexus is made.

Scalenus medius[21]: *origin*, posterior tubercles of the transverse processes of the six lower cervical vertebræ; *insertion*, upper surface of the first rib behind the subclavian groove; *action*, similar to the preceding; *nerves*, anterior branches from the cervical.

Scalenus posticus: *origin*, posterior tubercles of the two or three lower cervical vertebræ; *insertion*, outer surface of the esses; *insertion*, with the internal oblique as the *conjoined tendon* into the pubic crest and pectineal line, by its aponeurosis into the linea alba, the upper three-fourths passing *behind* the rectus abdominis, the remainder in *front* of that muscle; *action* and *nerves* similar to the internal oblique.

Lumbar fascia: the vertebral aponeurosis of the transversalis divides into an anterior thin layer attached to the front of the lumbar transverse processes and to the lower margin of the last rib, thus forming the *ligamentum arcuatum externum;* a middle, stronger layer, attached to the apices of the transverse processes; and a posterior layer attached to the apices of the spinous processes; the quadratus lumborum lies between the anterior and the middle layers, the erector spinæ between the middle and the posterior; the latter receives the attachment of the internal oblique, and blended with the aponeuroses of the serratus posticus inferior and latissimus dorsi forms the lumbar fascia, consisting of three layers.

Rectus abdominis[16]: *origin*, by two tendons from the pubic crest and ligaments over the symphysis pubis; *insertion*, cartilages of the fifth, sixth, and seventh ribs; this muscle is enclosed in a sheath, the upper three-fourths in front formed by the aponeurosis of the external oblique and half of that of the internal oblique, behind for the same extent the transversalis aponeurosis with the posterior division of that of the internal oblique; at the lower fourth the aponeuroses of all three muscles pass *in front* of the rectus; three or four tendinous intersections traverse the muscle called the *lineæ transversæ*, while the *lineæ semilunares*, two curved tendinous lines corresponding to the outer border of the recti muscles, extend on either side from the eighth costal cartilage to the pubes; *action*, flexes the thorax on the pelvis, and *vice versa*, also compresses the abdominal viscera; *nerves* are the lower intercostals and perhaps the ilio-hypogastric.

Pyramidalis: *origin*, from front of the pubic crest and anterior pubic ligament, lying in front of, but in same sheath with the rectus; *insertion*, linea alba midway between the pubes and the umbilicus; *action*, a tensor of the linea alba; *nerves*, two lower intercostals and sometimes the ilio-hypogastric.

Quadratus lumborum[19] (Fig. 89): *origin*, ilio-lumbar ligament, adjacent two inches of the iliac crest, and upper borders of the transverse processes of the three or four lower lumbar vertebræ;

insertion, one-half of the lower border of the last rib, apices of the transverse processes of the four upper lumbar vertebræ; *action*, flexes the trunk—both acting; flexes laterally—one acting; depresses the ribs with fixed pelvis and is then an expiratory muscle, but by fixing the last rib and opposing the diaphragm it is an *assistant to inspiration; nerves*, anterior branches of the last thoracic and upper lumbar.

Muscles of the Thorax.

External intercostals[11] (Fig. 90) (eleven pairs): *origin*, each from the outer lip of the groove on the lower border of each rib from the tuberosity to the costal cartilage; *insertion*, pass obliquely downward and forward to the upper border of the rib below for same distance; *action*, raise and evert the ribs in inspiration; *nerves* for each group are the intercostals.

Internal intercostals (eleven pairs): *origin*, each from the inner lip of the groove on the lower border of the rib reaching from the angle to the sternum; *insertion*, passing downward and backward to the upper border of the rib below; *action*, depress and invert the ribs in expiration; probably the two sets of intercostals act together in inspiration and in expiration, depending upon a fixed point above or below.

Infracostales or subcostales are placed posteriorly where the internal intercostals cease; they vary in number, and are most common between the lower ribs; *origin*, from the inner surface of one rib; *insertion*, inner surface of the first, second, or third rib below, passing obliquely downward and backward; *action*, same as the internal intercostals; *nerves*, intercostals.

Triangularis sterni: *origin*, lower part of the side of the sternum, inner surface of the ensiform cartilage, and sternal ends of the costal cartilages of the two or three lower true ribs; *insertion*, by fleshy digitations into the lower border and inner surfaces of the costal cartilages of the second to the sixth ribs inclusive; *action*, draws down the costal cartilages in expiration; *nerves*, intercostals.

Levatores costarum: *origin* (twelve pairs), extremities of seventh cervical and eleven upper thoracic transverse processes; *insertion*, rough surface between the tuberosity and angle of the rib below; *action*, assist the external intercostals in raising the ribs in inspiration; *nerves*, intercostals.

Diaphragm (Fig. 91): *origin*, arched and convex toward the chest, from the ensiform cartilage in front, on either side, inner surfaces of the cartilages and bony portions of the six or seven lower ribs, behind, from the ligamentum arcuatum externum [7] and internum [6], and by its crura [4], [5], the left from bodies of the two upper, the right, from those of the three or four upper lumbar vertebræ; *insertion*, into the central cordiform tendon [1], [2], [3]; *action*, chief respiratory muscle, increasing capacity of the chest by becoming flattened when contracted; also aids all efforts of expulsion; *nerves*, two phrenics and phrenic plexuses of the sympathetic.

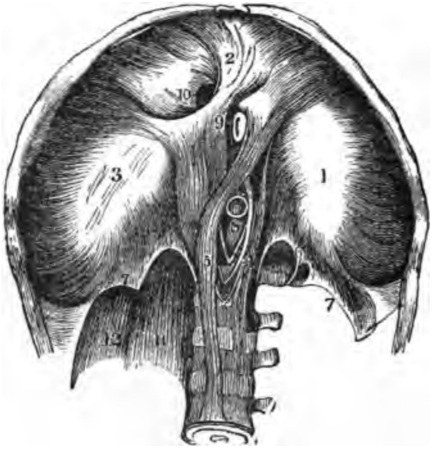


FIG. 91.—The diaphragm, inferior surface (Leidy).

Openings of the diaphragm: the *aortic* [8], median, in front of the vertebral bodies—really behind the diaphragm—for the aorta, vena azygos major, thoracic duct, sometimes the left sympathetic nerve; the *esophageal* [9], elliptical, muscular, formed by the crura, for the esophagus and pneumogastric nerves; the *opening for the vena cava* [10], highest, quadrilateral bounded by four tendinous bundles meeting at right angles; the right *crus* [5] transmits the sympathetic, greater and lesser splanchnic nerves; the *left crus* [4] the left greater and lesser splanchnic nerves and the vena azygos minor.

Muscles of the Shoulder and Arm.

Pectoralis major[1] (Fig. 90): *origin*, anterior surface of the inner half of the clavicle, half the breadth of the anterior surface of the sternum as low as the sixth or seventh cartilage, from the front of the second to the sixth cartilage, from the sixth rib, and from the aponeurosis of the external oblique; *insertion*, fibers converge and overlap, the lower being folded back upon themselves, to be attached by a flat tendon to the anterior lip of the bicipital groove of the humerus; *action*, draws the arm forward and inward; with fixed arm, an accessory muscle of forced inspiration; *nerves*, two anterior thoracics.

Pectoralis minor[6] (Fig. 90): *origin*, tendinous from the upper margin and the outer surface of the third, fourth, and fifth ribs near the cartilages, often from the second, and aponeurosis over the intercostal muscles; *insertion*, inner border and upper surface of the coracoid process of the scapula; *action*, depresses the point of the shoulder, elevates the ribs during inspiration when the scapula is fixed; *nerve*, internal anterior thoracic.

Subclavius[5]: *origin*, tendinous from the first costal cartilage and rib; *insertion*, groove on the middle third of the under surface of the clavicle; *action*, draws the clavicle down and in, steadies the sterno-clavicular articulation; *nerve*, branch from the trunk formed by the fifth and sixth cervical.

Serratus magnus[4] (Fig. 90): *origin*, by nine fleshy digitations from the outer surface and upper border of the eight upper ribs (second rib has two) and aponeurosis covering the upper intercostal spaces; *insertion*, whole length of the anterior aspect of the posterior border of the scapula; *action*, carries the scapula forward and is used in pushing, also raises the point of the shoulder by rotating the bone on the chest-wall; *nerve*, posterior thoracic.

Deltoid[2] (Fig. 90): *origin*, outer third of the anterior border and upper surface of the clavicle, outer margin and upper surface of the acromion process, and the whole length of the lower border of the spine of the scapula; *insertion*, tendinous into the rough prominence on the middle of the outer side of the shaft of the humerus; *action*, raises the arm to a right angle, also draws it forward by the anterior fibers, or slightly backward by the posterior portion; *nerve*, circumflex.

Subscapularis[4] (Fig. 92): *origin*, inner two-thirds of the subscapular fossa; *insertion*, lesser tuberosity and neck of the humerus; *action*, rotates the humerus inward and adducts; *nerves*, upper and lower subscapular.

Supraspinatus[17] (Fig. 88): *origin*, internal two-thirds of the supraspinous fossa and the fascia covering it; *insertion*, highest facet on the greater tuberosity of the humerus; *action*, assists the deltoid, fixes the head of the humerus in its socket; *nerve*, suprascapular.

Infraspinatus[18] (Fig. 88): *origin*, internal two-thirds of the infraspinous fossa; *insertion*, tendinous, middle facet of the greater tuberosity of the humerus; *action*, rotates the humerus outward, acts with neighboring tendons as a ligament of the shoulder-joint; *nerve*, suprascapular.

Teres minor[19] (Fig. 88): *origin*, upper two-thirds of the dorsal surface near the axillary border of the scapula and intermuscular septa; *insertion*, lowest facet on the greater tuberosity of the humerus and a small surface of the shaft below; *action*, rotates the humerus outward; *nerve*, circumflex.

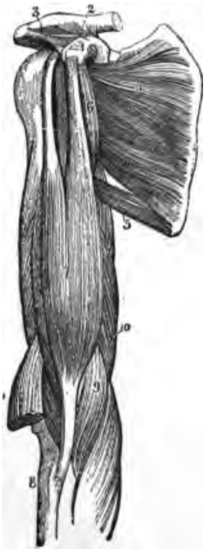


FIG. 92.—Anterior humeral region (Leidy).

Teres major[20] (Fig. 88): *origin*, lower third of the external border of the infraspinous fossa and intermuscular septa between it and the teres minor and infraspinatus; *insertion*, internal lip of the bicipital groove; *action*, draws the humerus downward and backward when raised, also rotates it inward; *nerve*, lower subscapular.

Coraco-brachialis[6] (Fig. 92): *origin*, fleshy from the apex of the coracoid process of the scapula; *insertion*, into the rough ridge at the middle of the inner border and surface of the humerus; *action*, draws the humerus forward and inward, also elevates it; *nerve*, special branch from the outer cord of the brachial plexus from the seventh cervical.

Biceps flexor cubiti[7] (Fig. 92): *origin*, *short head*, tendinous, in common with the coraco-brachialis from the tip of the coracoid process of the scapula, *long head*, upper margin of the glenoid cavity by a rounded tendon continuous with the glenoid ligament; *insertion*, tendinous into the back part of the tuberosity of the radius (a bursa is interposed in front), and by a broad aponeurosis opposite the elbow, into the fascia of the forearm; *action*, supinates and flexes the forearm, renders the forearm fascia tense; *nerve*, musculo-cutaneous.

Brachialis anticus[9]: *origin*, lower half of the outer and inner surfaces of the shaft of the humerus, embracing the insertion of the deltoid; *insertion*, tendinous into the inferior surface of the coronoid process of the ulna; *action*, flexes the forearm; *nerves*, musculo-cutaneous and musculo-spiral.

Triceps extensor cubiti[10]: *origin*, *scapular* or *long head* from the rough triangular depression below the glenoid fossa, the *external head* from the posterior surface of the shaft between the upper part of the spiral groove and the insertion of the teres minor, the *internal head* from the posterior surface below the spiral groove; *insertion*, tendinous, back part of the upper surface of the olecranon process of the ulna; *action*, extends the forearm and arm; *nerve*, musculo-spiral.

Subanconeus: *origin*, humerus above the olecranon fossa; *insertion*, posterior ligament of the elbow; *action*, prevents the loose capsule from being pinched during extension; *nerve*, musculo-spiral.

Muscles of the Forearm.

Anterior, or flexor and pronator group: All take origin from the internal epicondyle, except the deep layer.

Superficial layer.

Pronator teres[4] (Fig. 93): *origin*, double, above from the internal supracondylar ridge and common tendon, fascia of the forearm and intermuscular septum, below from the inner side of the coronoid process of the ulna; *insertion*, tendinous into the oblique line and rough ridge on the middle of the outer surface of the shaft of the radius; *action*, pronates the forearm and aids flexion; *nerve*, median.

Flexor carpi radialis[5]: *origin*, internal epicondyle by the common tendon, forearm fascia, and intermuscular septa; *insertion*, tendinous, into the base of the index metacarpal bone and usually of the third; *action*, flexes the wrist, then the forearm; also pronates the forearm; *nerve*, median.

Palmaris longus[6]: *origin*, inner epicondyle by the common tendon, fascia, and intermuscular septa; *insertion*, tendinous into the anterior annular ligament and palmar fascia, especially that over the thenar eminence; *action*, tightens the palmar fascia, flexes the wrist; *nerve*, median.

Flexor carpi ulnaris[8]: *origin*, double, by the common tendon from the inner epicondyle and from the inner margin of the olecranon by an aponeurosis, and from the upper two-thirds of the posterior border of the ulna and intermuscular septum; *insertion*, tendinous into the pisiform bone, annular ligament, unciform, and base of the fifth metacarpal by means of ligaments; *action*, flexes the hand on the forearm and adducts; then flexes the forearm on the arm; *nerve*, ulnar.

Flexor sublimis digitorum[7] **(perforatus)**: *origin*, by three heads, one from the inner epicondyle by the common tendon and from the internal lateral ligament and the intermuscular septa, a second from the inner side of the coronoid process of the ulna, the third from the oblique line of the radius; *insertion*, by four tendons, each of which splits for the passage of the deep flexor tendon, each half becoming attached to the middle of the lateral margins of the second phalanges; *action*, flexes the fingers, then the hand on the forearm, then the forearm on the arm; *nerve*, median.

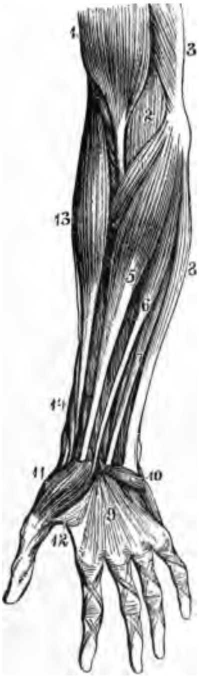


FIG. 93.—Muscles of the anterior region of the right forearm and hand (Leidy).

Deep layer.

Flexor profundus digitorum (perforans): *origin*, upper three-fourths of the anterior and internal surfaces of the ulna, inner side of the coronoid process, by an aponeurosis from the upper three-fourths of the posterior border of the ulna and ulnar half of the interosseous membrane; *insertion*, into bases of the last phalanges by four tendons, which pass between the two slips of the flexor sublimis tendons; *action*, flexes the fingers, then the wrist on the forearm; *nerves*, ulnar and anterior interosseous of the median.

Flexor longus pollicis: *origin*, anterior surface of the radius from the oblique line to the pronator quadratus, adjacent interosseous membrane, usually a second head from the base of the coronoid process or in common with the flexor sublimis from the inner epicondyle; *insertion*, base of the last phalanx of the thumb; *action*, flexes the last thumb-phalanx and wrist; *nerve*, anterior interosseous of the median.

Pronator quadratus: *origin*, oblique line on the lower fourth of the anterior surface of the ulna, the bone below this line, the anterior border of the ulna and aponeurosis over the muscle; *insertion*, lower fourth of the anterior surface and external border of the radius; *action*, pronates the radius upon the ulna; *nerve*, anterior interosseous of the median.

Radial region:

Nearly all the extensors and supinators arise from the external epicondyle and supracondylar ridge of the humerus.

Supinator longus (brachio-radialis)[13]: *origin*, upper two-thirds of the external supracondylar ridge and anterior surface of the external intermuscular septum; *insertion*, base of the styloid process of the radius; *action*, supinates forearm after it has been pronated, pronates after supination, flexes the forearm on the arm; *nerve*, musculo-spiral.

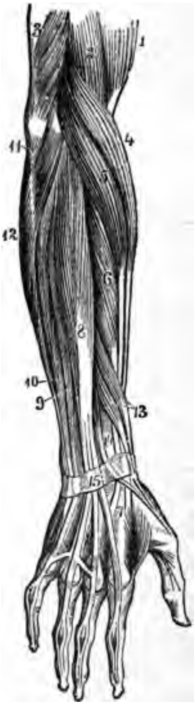


FIG. 94.—Muscles of the posterior region of the right forearm and hand (Leidy).

Extensor carpi radialis longior[5] (Fig. 94): *origin*, lower third of the external supracondylar ridge and anterior surface of the external intermuscular septum; *insertion*, radial side of the base of the metacarpal bone of the index finger; *action*, extends and abducts the wrist and flexes the elbow; *nerve*, musculo-spiral.

Extensor carpi radialis brevior[6]: *origin*, external condyle by the common tendon, external lateral ligament, the covering aponeurosis, and the intermuscular septa ; *insertion*, contiguous sides of the bases of the second and third metacarpal bones; *action*, extends the wrist and weakly extends the elbow ; *nerve*, posterior interosseous.

Posterior radio-ulnar region ; superficial layer :

Extensor communis digitorum[8] : *origin*, external epicondyle by the common tendon, deep fascia, and intermuscular septa ; *insertion*, tendon expands over the first phalanx, divides into three parts: the middle part goes to the second phalanx, the two lateral unite on the last ; *action*, extends the fingers, wrist, and elbow-joint ; *nerve*, posterior interosseous.

Extensor minimi digiti[9] : *origin*, intermuscular septa, rarely reaches the common tendon ; *insertion*, by two tendons which join the common extensor into the phalanges of the little finger ; *action*, extends the little finger ; *nerve*, posterior interosseous.

Extensor carpi ulnaris[10] : *origin*, by the common tendon from the external epicondyle, from the deep fascia, intermuscular septa, with a second head from the posterior border of the ulna ; *insertion*, ulnar side of the base of the fifth metacarpal ; *action*, extends and adducts the wrist ; extends the elbow ; *nerve*, posterior interosseous.

Anconeus : *origin*, back of the outer condyle of the humerus ; *insertion*, side of the olecranon and upper fourth of the posterior surface of the shaft of the ulna above the oblique line ; *action*, extends the forearm ; *nerve*, musculo-spiral.

Deep layer :

Supinator brevis[11] : *origin*, external condyle of the humerus, external lateral ligament and orbicular ligament of the radius, supinator ridge of the ulna, triangular depression in front of it and aponeurosis covering the muscle ; *insertion*, encircling the neck of the radius posteriorly, it is attached to the upper third of the shaft, the bicipital tuberosity, and the oblique line ; *action*, supinates and extends the forearm ; *nerve*, posterior interosseous, which pierces it.

Extensor ossis metacarpi pollicis[13] : *origin*, posterior surface of the shaft of the ulna below the anconeus, interosseous membrane, and middle third of the posterior surface of the shaft of the radius; *insertion*, radial side of the base of the first metacarpal, often a second slip to the trapezium or to the abductor pollicis; *action*, extends the first metacarpal; *nerve*, posterior interosseous.

Extensor brevis pollicis[13]: *origin*, posterior surface of the shaft of the radius and interosseous membrane; *insertion*, base of the first phalanx of the thumb; *action*, extends the phalanx on the metacarpal, abducts the wrist; *nerve*, posterior interosseous.

Extensor longus pollicis[14]: *origin*, posterior surface of the shaft of the ulna and interosseous membrane below the extensor ossis metacarpi; *insertion*, last phalanx of the thumb; *action*, extends the thumb, abducts the wrist; *nerve*, posterior interosseous.

Extensor indicis: *origin*, posterior surface of the shaft of the ulna below the extensor longus; *insertion*, with the tendon of the common extensor into the phalanges of the index finger on the ulnar side; *action*, extends the index finger and wrist; *nerve*, posterior interosseous.

Fasciæ of the Hand.

The **anterior annular ligament** is stretched between the *eminentia carpi*, which are the pisiform bone and the unciform process on one side, and the tuberosity of the scaphoid and the ridge of the trapezium on the other; it is continuous with the deep fascia of the forearm and the palmaris longus tendon, and is pierced by that of the flexor carpi radialis; beneath it pass the median nerve and, in one synovial sheath, the tendons of the flexor sublimis and profundus digitorum, and in a single sheath the tendon of the flexor longus pollicis.

The **posterior annular ligament**, continuous with the forearm fascia, is attached internally on the dorsum to the ulna, cuneiform, and pisiform bones and palmar fascia externally, to the ridges on the back of and margin of the radius. Six separate synovial compartments exist for the extensor tendons; from without inward they are: (1) outer side of the styloid process, for the extensor ossis metacarpi and extensor brevis pollicis; (2) behind same process, for the extensor carpi radialis longior and brevior; (3) next for the extensor longus pollicis; (4) more internally still, for the extensor communis digitorum and extensor indicis; (5) opposite the interval between the radius and ulna, for the extensor minimi digiti; and (6) back of the ulna, for the extensor carpi ulnaris.

The **palmar fascia**[9] (Fig. 93), consisting of a central and two lateral portions, invests the muscles of the hand, forming their common sheath; the central segment is triangular, attached to the palmaris longus and anterior annular ligament above, below dividing into four slips opposite the metacarpal heads, each slip dividing again to enclose the flexor tendons and be inserted on the sides of the first phalanges; strong transverse fibers connect the separate processes, and vertical septa, continuous on each side with the interosseous aponeurosis, separate the middle from the lateral palmar groups of muscles; beneath is the superficial palmar arch, median and ulnar nerves; the lateral portions of this fascia thinly invest the muscles of the thenar and hypothenar eminences.

Muscles of the Hand.

Abductor pollicis[11] (Fig. 93): *origin*, ridge of the trapezium and annular ligament; *insertion*, tendinous into the radial side of the base of the first thumb-phalanx; *action*, draws the thumb from the median line—*i. e.* abducts it; *nerve*, median.

Opponens pollicis: *origin*, palmar surface of the trapezium and annular ligament; *insertion*, whole length of the radial side of the thumb-metacarpal; *action*, flexes the metacarpal; *nerve*, median.

Flexor brevis pollicis[12] (Fig. 93): *origin*, by two heads, the external from the trapezium and outer two-thirds of the annular ligament; the internal rises from the inner side of the base of the first metacarpal between the abductor indicis and adductor obliquus pollicis; *insertion*, sides of the base of the first thumb-phalanx by two tendons, each containing a sesamoid bone; *action*, as name implies; *nerves*, median and ulnar.

Adductor obliquus pollicis rises from the os magnum, bases of the second and third metacarpals, and tendon-sheath of the flexor carpi radialis; *insertion*, ulnar side of the base of the first thumb-phalanx and internal sesamoid bone, and sends a fasciculus under the flexor longus tendon to the outer side of the base of the first phalanx; *action*, draws the thumb inward toward the median line; *nerve*, ulnar.

Adductor transversus pollicis: *origin*, lower two-thirds of the third metacarpal; *insertion*, ulnar side of the base of the first phalanx of the thumb; *action*, flexes the phalanx, adducts the thumb; *nerve*, ulnar.

The preceding muscles form the *thenar eminence*.

Palmaris brevis[10]: *origin*, tendinous from the annular ligament and palmar fascia; *insertion*, skin on the inner border of the palm; *action*, wrinkles the skin on the inner palmar side; *nerve*, ulnar.

Abductor minimi digiti: *origin*, pisiform bone and expansion of the tendon of the flexor carpi ulnaris; *insertion*, ulnar side of the base of the first phalanx of the little finger; *action*, draws the little finger from the median line and flexes the metacarpo-phalangeal joint; *nerve*, ulnar.

Flexor brevis minimi digiti: *origin*, tip of the unciform process and from the annular ligament; *insertion*, base of the first phalanx of the little finger with the abductor; *action*, flexes the first phalanx; *nerve*, ulnar.

Opponens minimi digiti: *origin*, beneath the preceding, from the unciform process and annular ligament; *insertion*, whole length of the fifth metacarpal; *action*, flexes the fifth metacarpal, and draws forward to deepen the hollow of the palm; *nerve*, ulnar.

The four preceding muscles form the *hypothenar eminence.*

Lumbricales: *origin*, tendons of the deep flexor; *insertion*, on radial side into the expansion of the extensor communis tendon over the dorsum of each finger; they are four in number; *action*, flex the first and extend the last two phalanges; *nerves*, two outer by the median, two inner by the ulnar.

Dorsal interossei (four in number): *origin*, by two heads from adjacent sides of the metacarpal bones; *insertion*, into bases of the first phalanges and aponeurosis of the common extensor; *action*, flex the first and extend the last two phalanges, abduct the fingers from a line passing through the center of the middle finger; *nerve*, ulnar.

Palmar interossei (three in number): *origin*, by single heads, from the palmar surface of the second, fourth, and fifth metacarpals; *insertion*, into three fingers as above; *action*, flex the first, extend the last two phalanges, and adduct the fingers toward the middle finger; *nerve*, ulnar.

Muscles of the Lower Extremity.

Psoas magnus[11] (Fig. 95): *origin*, margins of the bodies, intervertebral substances and bases of the transverse processes of the last thoracic and all the lumbar vertebræ; *insertion*, tendinous, with the iliacus, into the lesser trochanter; *action*, flexes the thigh on the pelvis, or *vice versa;* also rotates the femur outward; *nerves*, anterior branches of the second and third lumbar.

Psoas parvus (often absent): *origin*, margins of the bodies and intervertebral substance between the last thoracic and the first lumbar vertebræ; *insertion*, tendinous into the ilio-pectineal eminence and iliac fascia; *action*, tensor of the iliac fascia; *nerve*, anterior branch of the first lumbar.

Iliacus[10]: *origin*, upper half of the iliac fossa and inner margin of the iliac crest, ilio-lumbar ligament and base of the sacrum, anterior superior and inferior iliac spines, the notch between them; *insertion*, with the tendon of the psoas magnus into the lesser trochanter; *action*, same as the psoas magnus; *nerve*, anterior crural.

The **fascia lata**, or **deep fascia**, is attached above to Poupart's ligament and the iliac crest, behind to the margins of the sacrum and coccyx, internally to the pubic arch and linea ilio-pectinea, and below to the condyles of the femur, tuberosities of the tibia, and head of the fibula; three intermuscular septa pass from its inner surface to the whole length of the linea aspera; numerous smaller septa provide separate sheaths for each muscle; just below Poupart's ligament, at the upper inner aspect of the thigh, is the large oval *saphenous opening*, formed by the margins of the pubic and iliac portions of the fascia lata; *Poupart's ligament* is an artificial production, being in reality the thickened lower portion of the external oblique aponeurosis where the fascia lata becomes continuous with it.

Tensor fasciæ femoris[4]: *origin*, anterior part of the outer lip of the iliac crest and anterior superior iliac spine; *insertion*, fascia lata one-fourth down the thigh, whence the fascia is continued down to the tibial head as the *ilio-tibial band; action*, tensor of the fascia lata and internal rotator of the thigh; *nerve*, superior gluteal.

Sartorius[5]: *origin*, anterior superior iliac spine and upper half of the notch below it; *insertion*, aponeurotic into the upper inner surface of the shaft of the tibia; *action*, flexes the leg upon the thigh, the thigh upon the pelvis, and rotates out, at the same time drawing the limb inward, thus crossing one leg over the other; *nerve*, anterior crural.

Rectus femoris[6]: *origin*, by two tendons, the *straight* from the anterior inferior iliac spine, the *reflected* from the groove above the acetabulum; *insertion*, patella in common with the three next muscles; *action*, extends the leg and flexes the hip-joint; *nerve*, anterior crural.

Vastus externus[7]: *origin*, tubercle of the femur, great trochanter, rough line leading thence to the linea aspera, upper half of the outer lip of the linea aspera, and external intermuscular septum; *insertion*, aponeurotic into the outer border of the patella; *action*, extends the leg; *nerve*, anterior crural.

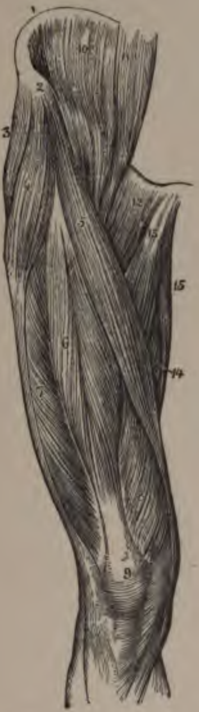


FIG. 95.—Muscles of the iliac and anterior femoral regions.

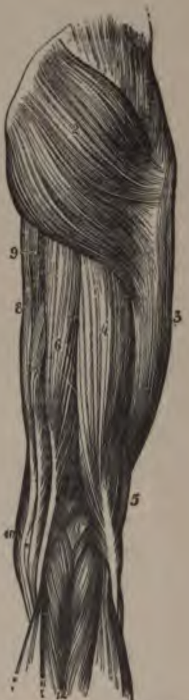


FIG. 96.—Muscles of the gluteal and posterior femoral regions.

(Leidy.)

Vastus internus and **crureus**[8]: *origin*, line leading from the inner side of the neck of the femur to the linea aspera and its whole inner lip, lower half of the outer lip, internal intermuscular septum, internal, anterior, and external surfaces of the shaft of the femur between the anterior intertrochanteric line and the lower fourth of the bone; *insertion*, aponeurotic, into the inner side of the patella, blending with other portions of the quadriceps tendon; *action*, extends the leg; *nerve*, anterior crural. The preceding four muscles are called the *quadriceps femoris*[6], [7], [8], whose tendon contains the patella[9], and is *inserted* into the tubercle of the tibia by the ligamentum patellæ.

Subcrureus: *origin*, often by two heads from the lower part of the shaft of the femur; *insertion*, upper part of the synovial pouch of the knee-joint; *action*, draws up the synovial sac; *nerve*, anterior crural.

Gracilis[15]: *origin*, aponeurotic from the inner margin of the body and descending ramus of the os pubis; *insertion*, upper inner surface of the shaft of the tibia above and behind the sartorius; *action*, flexes the leg, rotates it in, and adducts the thigh; *nerve*, obturator.

Pectineus[12]: *origin*, linea ilio-pectinea, the bone in front of it, and from fascia covering it; *insertion*, rough line passing from the lesser trochanter to the linea aspera; *action*, flexes, adducts, and rotates the thigh outward; *nerves*, anterior crural, obturator, and accessory obturator in order of frequency.

Adductor longus[13]: *origin*, body of the os pubis just below the angle; *insertion*, middle third of the linea aspera; *action*, adducts and flexes the thigh and rotates out; *nerve*, obturator.

Adductor brevis: *origin*, the body and outer surface of the descending ramus of the os pubis; *insertion*, upper part of the linea aspera; *action*, adducts and flexes the thigh; *nerve*, obturator.

Adductor magnus[14]: *origin*, descending ramus of the os pubis, ascending ramus, outer margin and under surface of the tuberosity of the ischium; *insertion*, rough line running from the great trochanter to the linea aspera, whole length of the linea aspera, and by a tendon into the tubercle above the inner condyle of the femur; between two portions of the muscle is an interval for the passage of the femoral vessels from Hunter's canal into the popliteal space; *action*, adducts and rotates the thigh outward, the long fibers to the tubercle may rotate in; *nerves*, obturator and great sciatic; the portion of the muscle attached to the femur presents four apertures for the perforating arteries.

Gluteus maximus[2] (Fig. 96): *origin*, superior gluteal line of the ilium and portion of the bone and crest just behind it, posterior surface of the last two pieces of the sacrum, side of the coccyx, aponeurosis of the erector spinæ muscle, and the great sacro-sciatic ligament; *insertion*, the fascia lata and rough line running from the great trochanter to the linea aspera between the vastus externus and the adductor magnus; *action*, maintains the trunk erect upon the thigh, extends, abducts, and rotates the thigh outward, is a tensor of the fascia lata; *nerve*, inferior gluteal.

Gluteus medius[1] (Fig. 96): *origin*, outer surface of the ilium between the superior and the middle gluteal lines, outer lip of the crest between the lines, and the gluteal aponeurosis; *insertion*, tendinous into the oblique line on the great trochanter; *action*, supports the trunk; the *posterior* fibers rotate the thigh outward and extend; the *anterior* fibers flex and rotate the thigh inward; the *middle* fibers abduct; *nerve*, superior gluteal.

Gluteus minimus[8] (Fig. 97): *origin*, outer surface of the ilium between the middle and the inferior gluteal lines and margin of the sciatic notch; *insertion*, anterior border of the great trochanter; *action*, flexes, abducts, and rotates the thigh inward, aids in maintaining the trunk erect; *nerve*, superior gluteal.

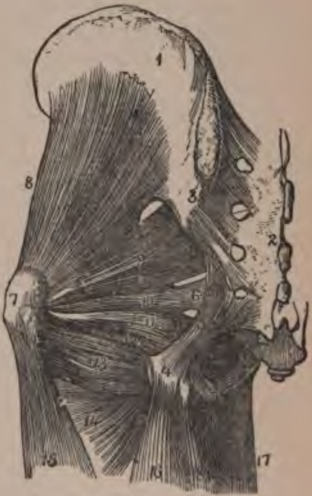


Fig. 97.—Muscles of the hip, posterior view (Leidy).

Pyriformis[9]: *origin*, by three fleshy digitations from the sacrum between the first, second, third, and fourth anterior sacral foramina, from grooves leading from them, from the ilium below the posterior inferior spine, and great sacro-sciatic ligament; *insertion*, passing out of the pelvis by the great sacro-sciatic foramen, is attached to the upper border of the great trochanter; *action*, an external rotator of the thigh after extension, and abductor after flexion; also draws the pelvis forward when fixed below; *nerves*, branches of the sacral plexus.

Obturator internus [11]: *origin*, internal surface and tendinous arch of the obturator membrane, margins of the obturator foramen, broad surface of the bone behind foramen; *insertion*, inner surface of the great trochanter after leaving the pelvis by the lesser sacro-sciatic foramen; four or five tendinous bands pass in the substance of the muscle from its origin to its insertion; *action*, similar to the pyriformis; *nerve*, branch of the sacral plexus.

Gemellus superior [10]: *origin*, spine of the ischium; *insertion*, with the tendon of the obturator internus into the inner surface of the great trochanter; *action*, rotates the thigh outward; *nerve*, from the branch to the obturator internus.

Gemellus inferior [12]: *origin*, tuberosity of the ischium; *insertion*, great trochanter with the obturator internus; *action*, an external rotator of the thigh; *nerve*, twig from the branch to the quadratus femoris.

Obturator externus: *origin*, inner anterior margin of the obturator foramen and inner two-thirds of the outer surface of the obturator membrane; *insertion*, digital fossa of the femur; *action*, an external rotator of the thigh, may flex and adduct; *nerve*, deep branch of the obturator.

Quadratus femoris [13]: *origin*, outer border of the tuber ischii; *insertion*, a tubercle at the center of the posterior intertrochanteric line; *action*, external rotator of the thigh and an adductor; *nerve*, branch of the sacral plexus.

Biceps [16] [4,5] (Fig. 96); (Fig. 97): *origin*, by two heads, the *long* [16] from the lower inner facet on the tuber ischii by the tendon common to it and the semitendinosus and from the great sacro-sciatic ligament, the *short head* [5] (Fig. 96), from the linea aspera between the adductor magnus and the vastus externus, and from the intermuscular septum; *insertion*, outer side of the head of the fibula, the tendon splitting to embrace the long external lateral ligament of the knee, one band extending to the outer tuberosity of the tibia; this muscle forms the *outer hamstring; action*, extends the hip, flexes the leg, after which it slightly rotates it outward; *nerve*, great sciatic.

Semitendinosus [6] (Fig. 96), [18] (Fig. 97): *origin*, by the common tendon with the biceps to the length of three inches from the tuberosity of the ischium and adjacent aponeurosis; *insertion*, upper inner surface of the shaft of the tibia, behind the sartorius and below the gracilis; *action*, extends the hip, flexes the leg on the thigh, rotates it in; *nerve*, great sciatic.

Semimembranosus[7] (Fig. 96): *origin*, tendinous from the upper outer facet on the tuberosity of the ischium; *insertion*, groove on the inner tuberosity of the tibia, connected with the popliteal oblique ligament and with the fascia covering the popliteus muscle, a few fibers forming the short internal lateral ligament of the knee-joint; *action*, extends the hip, flexes the leg on the thigh, rotates it in; *nerve*, great sciatic; the tendons of the semimembranosus and semitendinosus form the *inner hamstrings.*

Muscles of the Leg.

Tibialis anticus[3] (Fig. 98): *origin*, outer tuberosity and upper two-thirds of the external surface of the shaft of the tibia, adjacent interosseous membrane, deep surface of the fascia, and intermuscular septum; *insertion*, inner and under surface of the front part of the internal cuneiform bone, base of the first metatarsal; *action*, flexes the ankle-joint, rotates the foot inward, adducts the forefoot; *nerve*, anterior tibial.

Extensor longus hallucis[5]: *origin*, middle two-fourths of the anterior surface of the fibula, and to the same extent from the interosseous membrane; *insertion*, base of the last phalanx of the great toe, usually with a slip to the base of the first phalanx; *action*, extends the great toe, otherwise same as the tibialis anticus; *nerve*, anterior tibial.

Extensor longus digitorum[4]: *origin*, outer tuberosity of the tibia, upper two-thirds of the anterior surface of the fibula, interosseous membrane, deep surface of the fascia, and intermuscular septa; *insertion*, divides into four tendons, which are attached to the three phalanges of the four lesser toes; *action*, extends the toes, flexes the ankle, everts the foot, abducts the forefoot; *nerve*, anterior tibial.

Peroneus tertius[6]: *origin*, lower third of the anterior surface of the fibula, interosseous membrane, and intermuscular septum; *insertion*, upper part of the bases of the fourth and fifth metatarsals; *nerve* and *action* on the foot same as those of the long extensor.

foramen, is attached to the upper border of the great trochanter; *action*, an external rotator of the thigh after extension, and abductor after flexion; also draws the pelvis forward when fixed below; *nerves*, branches of the sacral plexus.

Obturator internus^{11}: *origin*, internal surface and tendinous arch of the obturator membrane, margins of the obturator foramen, broad surface of the bone behind foramen; *insertion*, inner surface of the great trochanter after leaving the pelvis by the lesser sacro-sciatic foramen; four or five tendinous bands pass in the substance of the muscle from its origin to its insertion; *action*, similar to the pyriformis; *nerve*, branch of the sacral plexus.

Gemellus superior^{10}: *origin*, spine of the ischium; *insertion*, with the tendon of the obturator internus into the inner surface of the great trochanter; *action*, rotates the thigh outward; *nerve*, from the branch to the obturator internus.

Gemellus inferior^{12}: *origin*, tuberosity of the ischium; *insertion*, great trochanter with the obturator internus; *action*, an external rotator of the thigh; *nerve*, twig from the branch to the quadratus femoris.

Obturator externus: *origin*, inner anterior margin of the obturator foramen and inner two-thirds of the outer surface of the obturator membrane; *insertion*, digital fossa of the femur; *action*, an external rotator of the thigh, may flex and adduct; *nerve*, deep branch of the obturator.

Quadratus femoris^{13}: *origin*, outer border of the tuber ischii; *insertion*, a tubercle at the center of the posterior intertrochanteric line; *action*, external rotator of the thigh and an adductor; *nerve*, branch of the sacral plexus.

Biceps^{16} ^{4},^{5} (Fig. 96); (Fig. 97): *origin*, by two heads, the *long*^{16} from the lower inner facet on the tuber ischii by the tendon common to it and the semitendinosus and from the great sacro-sciatic ligament, the *short head*^{5} (Fig. 96), from the linea aspera between the adductor magnus and the vastus externus, and from the intermuscular septum; *insertion*, outer side of the head of the fibula, the tendon splitting to embrace the long external lateral ligament of the knee, one band extending to the outer tuberosity of the tibia; this muscle forms the *outer hamstring; action*, extends the hip, flexes the leg, after which it slightly rotates it outward; *nerve*, great sciatic.

Semitendinosus^{6} (Fig. 96),^{18} (Fig. 97): *origin*, by the common tendon with the biceps to the length of three inches from the tuberosity of the ischium and adjacent aponeurosis; *insertion*, upper inner surface of the shaft of the tibia, behind the sartorius and below the gracilis; *action*, extends the hip, flexes the leg on the thigh, rotates it in; *nerve*, great sciatic.

Semimembranosus[7] (Fig. 96): *origin*, tendinous from the upper outer facet on the tuberosity of the ischium; *insertion*, groove on the inner tuberosity of the tibia, connected with the popliteal oblique ligament and with the fascia covering the popliteus muscle, a few fibers forming the short internal lateral ligament of the knee-joint; *action*, extends the hip, flexes the leg on the thigh, rotates it in; *nerve*, great sciatic; the tendons of the semimembranosus and semitendinosus form the *inner hamstrings*.

Muscles of the Leg.

Tibialis anticus[3] (Fig. 98): *origin*, outer tuberosity and upper two-thirds of the external surface of the shaft of the tibia, adjacent interosseous membrane, deep surface of the fascia, and intermuscular septum; *insertion*, inner and under surface of the front part of the internal cuneiform bone, base of the first metatarsal; *action*, flexes the ankle-joint, rotates the foot inward, adducts the forefoot; *nerve*, anterior tibial.

Extensor longus hallucis[5]: *origin*, middle two-fourths of the anterior surface of the fibula, and to the same extent from the interosseous membrane; *insertion*, base of the last phalanx of the great toe, usually with a slip to the base of the first phalanx; *action*, extends the great toe, otherwise same as the tibialis anticus; *nerve*, anterior tibial.

Extensor longus digitorum[4]: *origin*, outer tuberosity of the tibia, upper two-thirds of the anterior surface of the fibula, interosseous membrane, deep surface of the fascia, and intermuscular septa; *insertion*, divides into four tendons, which are attached to the three phalanges of the four lesser toes; *action*, extends the toes, flexes the ankle, everts the foot, abducts the forefoot; *nerve*, anterior tibial.

Peroneus tertius[6]: *origin*, lower third of the anterior surface of the fibula, interosseous membrane, and intermuscular septum; *insertion*, upper part of the bases of the fourth and fifth metatarsals; *nerve* and *action* on the foot same as those of the long extensor.

Gastrocnemius[10]: *origin*, by two heads from the upper back part of the condyles of the femur and supracondylar ridges; *insertion*, with the tendons of the soleus and plantaris to form the tendo Achillis, which is inserted into the middle part of the tuberosity of the os calcis; *action*, extends the foot and slightly rotates it in; *nerve*, internal popliteal.

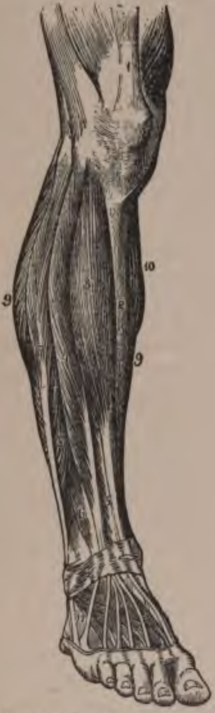


FIG. 98.—Anterior muscles of the right leg.

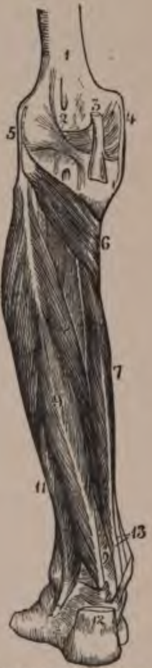


FIG. 99.—Posterior muscles of the left leg, deep layer.

(Leidy.)

Soleus[9],[9]: *origin*, tendinous, from the back of the head and upper third of the posterior surface of the fibula, from the oblique line of the tibia, and from the middle third of its inner border; *insertion*, tuberosity of the os calcis by the tendo

Achillis; *action*, as above; *nerves*, internal popliteal and posterior tibial.

Plantaris: *origin*, lower part of the outer bifurcation of the linea aspera and posterior ligament of the knee-joint; *insertion*, posterior surface of the os calcis with the tendo Achillis, into the tendo Achillis, or into the plantar fascia; *action*, accessory to the gastrocnemius; *nerve*, internal popliteal.

Popliteus[6] (Fig. 99): *origin*, within the knee-joint from the depression on the outer side of the external condyle of the femur, and from the arcuate ligament or posterior part of the capsule; *insertion*, triangular surface above the oblique line of the tibia posteriorly, and tendinous expansion covering the muscle; *action*, flexes the leg upon the thigh, then rotates the tibia inward, and draws the capsule backward; *nerve*, internal popliteal.

Flexor longus hallucis[9] (Fig. 99): *origin*, lower two-thirds of the posterior surface of the fibula, except its lowest inch, lower part of the interosseous membrane, intermuscular septum, deep fascia, and fascia covering the tibialis posticus; *insertion*, base of the last phalanx of the great toe; in the foot always giving a tendon to the flexor longus digitorum; *action*, flexes the great toe, then extends the foot; *nerve*, posterior tibial.

Flexor longus digitorum[7] (Fig. 99): *origin*, posterior surface of the tibia below the oblique line internal to the tibialis posticus, except the lower three inches, deep fascia, also the intermuscular septum; its tendon passes behind the malleolus in the groove with the tibialis posticus, but in a separate synovial sheath; *insertion*, bases of the phalanges of the lesser toes by four tendons, each passing through a fissure in the tendon of the flexor brevis; *action*, flexes the phalanges, and then extends the foot; *nerve*, posterior tibial. With this muscle are connected the lumbricales and the accessorius.

Tibialis posticus[8] (Fig. 99): *origin*, by two pointed processes, between which pass the anterior tibial vessels, from the whole of the posterior surface of the interosseous membrane except the lowest part, posterior surface of the tibia, external to the flexor longus, between the oblique line above and the middle of the external border below, and from the whole of the internal surface of the fibula; *insertion*, tuberosities of the navicular and internal cuneiform, and sends offsets to the middle and external cuneiform, cuboid, sustentaculum tali, and bases of the second, third, and fourth metatarsals; *action*, extends the foot, adducts and rotates in; *nerve*, posterior tibial.

Peroneus longus[7] (Fig. 98): *origin*, outer tuberosity of the tibia, head and upper two-thirds of the outer surface of the fibula, deep surface of the fascia, and intermuscular septa, then it grooves the outer malleolus with the peroneus brevis[8], then the os calcis and cuboid; *insertion*, outer side of the base of the first metatarsal and internal cuneiform; *action*, extends and everts the foot; *nerve*, musculo-cutaneous.

Peroneus brevis[8] (Fig. 98): *origin*, lower two-thirds of the outer surface of the shaft of the fibula, intermuscular septa; *insertion*, passes with the preceding muscle behind the external malleolus in a groove lined with a common synovial sheath, to be attached to the dorsum of the base of the fifth metatarsal, and sends a slip to the long extensor of the little toe; *action* and *nerve*, same as the peroneus longus.

Fasciæ of the Foot.

The **anterior annular ligament** consists of (1) an upper vertical portion binding down the extensor tendons, attached to the lower ends of the tibia and fibula, continuous above with the deep fascia, and containing only one synovial sheath situated internally for the tendon of the tibialis anticus; the extensor longus digitorum, peroneus tertius, and extensor longus hallucis tendons, the anterior tibial vessels and nerve pass beneath it without a distinct sheath; and (2) a horizontal portion attached externally to the upper surface of the os calcis, and internally are two diverging arms, one to the inner malleolus and one to the plantar fascia, containing three sheaths, that internal for the tendon of the tibialis anticus, the next for the extensor longus hallucis, and that most external for the extensor longus digitorum and peroneus tertius.

The **internal annular ligament** is a strong band extending from the inner malleolus to the inner margin of the os calcis, converting the bony grooves on its surface into canals for the flexor tendons and the tibial vessels and nerves; it is continuous with the deep fascia of the leg, plantar fascia, and the origin of the abductor hallucis muscle. Its three fibro-osseous canals transmit, enumerated obliquely from within outward, the tendons of the tibialis posticus, flexor longus digitorum, posterior tibial vessels and nerve—through a broad space beneath the ligament—and the tendon of the flexor longus hallucis.

The **external annular ligament** stretches between the extremity of the outer malleolus to the outer surface of the os calcis, forming a common sheath for the peroneal tendons.

The **plantar fascia**, the densest of all fibrous membranes, consists of a central and two lateral parts; the former, thick and narrow behind, arising from the inner tubercle of the os calcis, divides into a process for every toe, each again splitting opposite the metatarso-phalangeal joint into two slips—over which passes the flexor tendon—to be attached to the sides of the metatarsal bone and transverse metatarsal ligament; two chief and several subordinate intermuscular septa are given off, separating the muscular layers; the outer and inner segments are thin, the outer has one strong band giving origin in part to the abductor minimi digiti.

Muscles of the Foot.

Dorsal region.

Extensor brevis digitorum: *origin*, outer surface of the os calcis, external calcaneo-astragaloid ligament, and annular ligament; *insertion*, by four tendons, the first into the first phalanx of the great toe, and is named the *extensor brevis hallucis;* the other three into the outer sides of the long extensor tendons of the second, third, and fourth toes; *action*, accessory to the extensors on the four inner toes; *nerve*, anterior tibial.

Plantar region. First layer.

Abductor hallucis [3] (Fig. 100): *origin*, inner tubercle of the os calcis, internal annular ligament, navicular bone, plantar fascia, and intermuscular septum; *insertion*, with inner tendon of the flexor brevis hallucis into the inner side of the base of the first phalanx of the great toe; *action*, abducts the great toe; *nerve*, internal plantar.

Flexor brevis digitorum [5]: *origin*, tendinous from the inner tubercle of the os calcis, central part of the plantar fascia and the intermuscular septa; *insertion*, by four tendons to the four lesser toes, perforated opposite the middle of the first phalanges by the tendons of the long flexor; beyond the perforations the tendons split to be inserted into the sides of the second phalanges; *action*, flexes the lesser toes; *nerve*, internal plantar.

Abductor minimi digiti[4]: *origin*, outer tubercle of the os calcis, the bone in front of both tubercles, plantar fascia, and intermuscular septum; *insertion*, with the short flexor of the little toe into the outer side of the base of the first phalanx; *action*, abducts the little toe; *nerve*, external plantar.

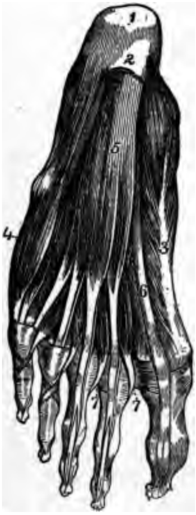


FIG. 100.—Muscles of the sole of the foot, first layer (Leidy).

Second layer.

Flexor accessorius: *origin*, by two heads, from the concave surface of the calcis and inferior calcaneo-navicular ligament, from the os calcis in front of the outer tubercle, and from the long plantar ligament; *insertion*, outer margin and upper and under surfaces of the tendon of the long flexor of the toes; *action*, modifies the oblique pull of the long flexor; *nerve*, external plantar.

Lumbricales[7]: *origin*, tendons of the long flexor; *insertion*, expansion of the long extensor over the first phalanges; *action*, flex the first phalanx, extend the last two; *nerves*, the innermost lumbricalis by the internal, the three outer by the external plantar nerve.

Third layer.

Flexor brevis hallucis: *origin*, inner border of the cuboid and contiguous portion of the external cuneiform, and prolongation of the tibialis posticus tendon; *insertion*, inner and outer side of the base of the first phalanx of the great toe by two tendons, each containing a sesamoid bone, the inner tendon blending with that of the abductor hallucis, the outer with that of the adductor obliquus and the adductor transversus hallucis; *action*, flexes the great toe; *nerve*, internal plantar.

Adductor obliquus hallucis: *origin*, tarsal extremities of the second, third, and fourth metatarsal bones and sheath of the tendon of the peroneus longus; *insertion*, with outer portion of the short flexor into the outer side of the base of the first phalanx of the great toe; *action*, adducts the great toe; *nerve*, external plantar.

Adductor transversus hallucis: *origin*, inferior metatarso-phalangeal ligaments of the three outer toes and transverse metatarsal ligament; *insertion*, with the adductor obliquus hallucis into the outer side of the first phalanx of the great toe; *action*, adducts the great toe; *nerve*, external plantar.

Flexor brevis minimi digiti: *origin*, base of the fifth metatarsal and sheath of the peroneus longus tendon; *insertion*, outer side of the base of the first phalanx of the little toe, often to the head of the fifth metatarsal; *action*, flexes and abducts the first phalanx; *nerve*, external plantar.

Fourth layer.

Dorsal interossei (four): *origin*, each by two heads from the adjacent sides of the metatarsal bones; *insertion*, tendinous into the bases of the first phalanges and aponeuroses of the common extensor; *action*, flexes the first phalanx, extends the last two, abducts toes from an imaginary line passing through the center of the second toe; *nerves*, external plantar and anterior tibial.

Plantar interossei (three): *origin*, single heads from the base and inner sides of the shaft of the third, fourth, and fifth metatarsal bones; *insertion*, inner sides of the bases of the phalanges and extensor aponeuroses of the same toes; *action*, flex and extend as above, and adduct the toes toward a line passing through the middle of the second toe; *nerve*, external plantar.

THE VASCULAR SYSTEM.

What is the pericardium?

A closed fibro-serous sac of conical form, its apex surrounding the great vessels for about two inches above their origin, its base downward, attached to the central tendon of the diaphragm. The outer fibrous coat is continued as tubular prolongations, lost upon the external coats of the roots of all the great vessels except the inferior vena cava, and is finally traceable as continuous with the deep layer of the cervical fascia; the serous coat lines the sac, forming a *parietal layer*, and is reflected over the heart and great vessels, forming a *visceral layer;* its function is the secretion of a thin fluid in sufficient amount to moisten the surfaces, thus lessening friction during the heart's movements.

Describe the heart and its position.

It is a hollow, conical muscle, with four distinct cavities, situated obliquely between the lungs, the base upward, backward, and to the right, the apex[11] (Fig. 101) downward, forward, and to the left, corresponding to the fifth intercostal space, three and a half inches from the middle line of the sternum. The *upper limit* of the heart is represented by a line passing from the lower border of the second left costal cartilage to the upper border of the third on the right side. The *auriculo-ventricular groove* is shown by a line drawn obliquely from the sternal end of the third left cartilage to the upper border of the sternal end of the seventh on the right side. The *right border* is represented by a line from the third right to the seventh right chondro-sternal articulation, arching outward one and a half inches from the middle line; the *lower limit*, by a line from the seventh right articulation to the apex in the fifth space; the *left border*, from the second left cartilage to the apex.

The *pulmonary valve* is covered by the sternal end of the third left cartilage; the *aortic valve* is a little below and internal to this, behind the sternum, on a level with the third space, between the mid-sternal and left sternal lines. The auriculo-ventricular openings are lower than the arterial. The *mitral* is at the sternal end of the third left space (behind the sternal end of the fourth left costal cartilage, Quain). Draw a horizontal line between the two sternal ends of the fifth cartilages; where this line intersects the one marking the auriculo-ventricular groove is the spot indicating the *tricuspid valve*, behind the sternum.

Give the size and weight of the heart.

In adults it measures five inches long, three and one-half broad, and two and one-half thick; weighs in the male ten to twelve ounces, in proportion to the body 1 to 169; in females, eight to ten ounces, 1 to 149.

What are the four cavities of the heart called?

The right auricle[3] and the right ventricle[4], the left auricle and the left ventricle, separated by a longitudinal septum—indicated externally in front and behind by the *interventricular grooves*—dividing the heart into lateral halves, the right or venous heart, the left or arterial heart; an oblique *auriculo-ventricular groove* on the exterior corresponds to the division between the auricles and the ventricles.

Describe the right auricle.

Larger than the left auricle, with a capacity of about two fluid ounces; its walls are about one line thick; the venous blood is poured in by the superior[1] and the inferior venæ cavæ[2] and the coronary sinus; note the following points:

The *sinus* or *atrium*, the large quadrangular cavity between the two venæ cavæ; the *appendix auriculæ*, a conical pouch with dentated edge, projecting forward to the left over the root of the aorta[8]; *openings* of the two venæ cavæ, also that of the coronary sinus[3''], its orifice guarded by a semicircular fold called the *coronary valve*—sometimes two unequal segments are found; the *tubercle of Lower*[3], a small projection on the right upper wall directing blood from the superior cava toward the auriculo-ventricular opening, not marked in man; the *foramina Thebesii*, the mouths of numerous minute veins returning blood from the heart-muscle; *openings* of a few anterior cardiac veins; the semilunar *Eustachian valve*[3'] between the anterior margin of the inferior vena cava and auriculo-ventricular opening—it is larger in the fetus, serving to direct the blood of the inferior cava through the foramen ovale; the *fossa ovalis*[3'], an oval depression at the lower part of the auricular septum, the site of the oval foramen in the fetus; the *annulus ovalis*, the prominent margin of the fossa ovalis; the *musculi pectinati*, small prominent muscular columns running across the inner surface of the appendix and adjoining wall of the sinus; the oval *auriculo-ventricular orifice*, about one inch in diameter, communicating with the right ventricle, its margins formed by a fibrous ring covered by the lining membrane, and guarded by the tricuspid valve.

Describe the right ventricle.

It is triangular, with the apex downward, not quite reaching that of the heart, forming with the right auricle the anterior, rather than the right side of the heart; its capacity is about three fluid ounces; it presents the following points for examination:

Above is the conical prolongation called the *conus arteriosus*, from which opens the *pulmonary artery* placed to the left of the auriculo-ventricular orifice, which is surrounded by a fibrous ring; the pulmonary *semilunar valves* guard the pulmonary orifice; the *tricuspid valve*^{5}, $^{5'}$, $^{5''}$, formed of three triangular segments—the largest on the left side—by a reduplication of the lining membrane with interposed fibrous tissue; the flaps are called the *left*, *right*, and *posterior* or *septal;* they are prevented from being forced into the auricle by the

Chordæ tendineæ$^{5''}$, fine tendinous cords stretching from (1) the columnæ carneæ to the attached margins of the leaflets, (2) to their centers, and (3) to their free margins.

The *columnæ carneæ*$^{4'}$, three varieties of muscular columns, (1) simple ridges, (2) bands attached by both extremities, and (3) two *musculi papillares*, muscular eminences from which arise the chordæ tendineæ. The anterior muscle is larger and more constant than the posterior, which may be represented by two or three smaller muscles.

The three *pulmonary semilunar valves*^{4}, two anterior, a right and a left, and one posterior, formed by a reduplication of the lining membrane with interposed fibrous tissue, with their free margins strengthened by a bundle of fibrous tissue, whose fibers radiate from a fibro-cartilaginous nodule—*corpus Arantii*—to all parts, except to two narrow lunated portions (*lunulæ*) on either side of the nodule, which are forced into contact when the valves are closed; above and behind each valve is a dilatation, the *sinus of Valsalva.*

Describe the left auricle.

Resembles the right in having a principal cavity or sinus and an appendix, but its walls are thicker, measuring about one and one-half lines. The following points should be studied:

The *openings of the pulmonary veins*, usually four in number, two emptying into the right and two into the left side; frequently the latter terminate by a common opening.

The *oval auriculo-ventricular opening*, surrounded by a fibrous ring, smaller than the right; the *musculi pectinati* fewer and smaller than on the right side; a *depression* over the site of the fossa ovalis of the right auricle.

Describe the left ventricle.

Larger and more conical than the right, it forms but little of the anterior surface, most of the inferior surface and all the apex[11] of the heart, its walls being three times as thick as those of the right ventricle; its inner surface presents, for examination:

The *circular aortic opening*, with the usual fibrous ring, in front and to the right of the auriculo-ventricular opening, between them intervenes one of the segments of the mitral valve, its mouth being guarded by three semilunar valves; the *mitral valve*, composed of two irregular segments—the larger in front—similar to those of the tricuspid valve, but larger and thicker, the leaflets being provided with chordæ tendineæ, whose mode of attachment is identical with those of the right side. The *semilunar aortic valves* resemble those of the pulmonary artery, but are larger and stronger; two are anterior and one poste-

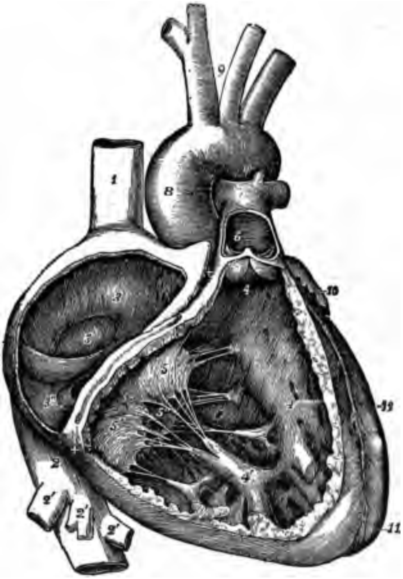


FIG. 101.—The heart, with right auricle and right ventricle laid open (Leidy).

rior in the fetal condition, but in the adult one is anterior and two are posterior, right and left; the *sinuses of Valsalva* are like those of the pulmonary artery, and are found behind the aortic valves.

The *columnæ carneæ* are more numerous, but smaller than on the right side, while there are only two *musculi papillares.*

What is the endocardium?

The delicate lining membrane of the heart continuous with the intima of the great vessels, by its reduplications forming the various valves.

Describe the heart-structure.

It consists of *striated anastomosing* muscular fibers taking origin from the fibrous rings surrounding the aortic, pulmonary, and auriculo-ventricular openings, disposed in the *auricles* in a *deep layer* composed of looped and annular fibers, and a *superficial* transverse layer; in the *ventricles* numerous layers have been described, the deepest of which run circularly, the more superficial spirally, curving round the apex to form the *whorl* or *vortex*, those fibers from in front curving around to enter posteriorly, and *vice versa;* the most superficial fibers, especially those behind, pass across the septum from one ventricle to the other.

The Arteries.

What are the arteries?

Cylindrical, tubular vessels conveying blood *from* both ventricles *to* all parts of the body; the blood they carry is called *arterial*, except in the case of the pulmonary artery conveying venous blood to the lungs, and the four pulmonary veins returning arterial blood to the left auricle, constituting the *lesser* or *pulmonic circulation*, while the aorta arising from the left ventricle carrying blood to the body generally, and the veins returning it, finally emptying by the two venæ cavæ into the right auricle, form the *greater* or *systemic circulation.* In their distribution the arteries freely communicate with one another, the large branches as well as the small forming what are called *collateral anastomoses* or *inosculations*, permitting the establishment of a collateral circulation after obliteration of a main artery.

Describe the structure of the arteries.

They possess three coats: (1) an *internal* (serous) or *intima;* (2) a *middle* (*media*), composed in small vessels almost purely of circular muscular fibers, in the larger chiefly of yellow elastic tissue; this prevents the arteries from collapsing when cut across; (3) an *external* (*adventitia*), composed of connective tissue. Every vessel, except the intracranial vessels, is included with its vein or veins in a fibro-areolar *sheath.*

How are the arteries nourished and their caliber regulated?

The larger vessels are supplied by minute *vasa vasorum*, blood-vessels distributed in a fine network to their external coats; while intricate nerve-networks (plexuses), chiefly derived from the sympathetic, partly from the spinal system, supply the two outer coats of the large vessels—the smaller are usually supplied only with single filaments.

What are capillaries?

The intermediate vessels between the arteries and veins, disposed in the form of a network, of an average diameter of one-three-thousandths of an inch, formed of a fine transparent layer of endothelial cells united by a cement-substance.

Describe the pulmonary artery.

It is a wide vessel conveying venous blood from the right ventricle to the lungs, about two inches long, and springs, in front of the aorta, from the left side of the base of the right ventricle, lying within the pericardium, passing obliquely to the left, upward and backward, dividing at the under

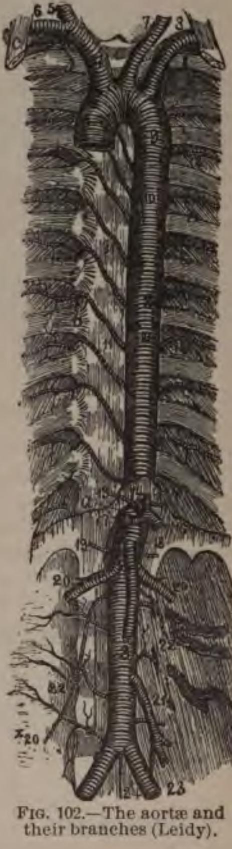


FIG. 102.—The aortæ and their branches (Leidy).

surface of the aortic arch into a *right* and a *left pulmonary artery*, the former the longer; each vessel pierces the pericardium and passes horizontally outward to its respective lung, where it divides into two main branches, one of those of the right subdividing to supply the third lobe; these vessels subdivide to terminate in the pulmonary capillaries.

Describe the aorta[1], [2], [3] (Fig. 102).

This, the main trunk of the systemic arteries, arises from the upper part of the left ventricle, ascends and then arches backward to the left over the root of the left lung to descend within the thorax on the left side of the vertebral column, entering the abdominal cavity by the aortic opening[a] behind the diaphragm, where it terminates opposite the fourth lumbar vertebra in the two common iliac arteries[23]; the aorta is divided for convenience of study into the *ascending aorta*, *arch of the aorta*,[1] *thoracic*[2], and *abdominal aorta*[3]. The branches of each subdivision are:

From the ascending aorta	Two coronary.
From arch of the aorta	Innominate, Left common carotid, Left subclavian.
From the thoracic aorta	Pericardiac, Posterior mediastinal, Bronchial[9], Intercostal[11], [12], Esophageal[10].

From the abdominal aorta are three groups with three in each:

Visceral	Celiac axis	Gastric[15], Hepatic[17], Splenic[16].
	Superior mesenteric[18],	
	Inferior mesenteric[21].	
Glandular	Two renal[20],	
	Two suprarenal[19],	
	Two spermatic[x20], or ovarian.	
Parietal	Ten lumbar[22],	
	Two inferior phrenic[13],	
	One middle sacral[24].	

Give the relations of the aorta in the thorax.

Ascending aorta : anterior, pulmonary artery, right auricular appendix, pericardium; *posterior*, right pulmonary artery, right bronchus, left auricle, pericardium; *right side*, superior vena cava, right auricle; *left side*, pulmonary artery.

Arch of the aorta : anterior, pleuræ and lungs, remains of the thymus gland, left pneumogastric nerve, left phrenic nerve, left superior cardiac nerves, left superior intercostal vein; *posterior*, trachea, deep cardiac plexus, esophagus, thoracic duct, left recurrent nerve; *above*, left innominate vein, innominate artery, left carotid, left subclavian; *below*, bifurcation of the pulmonary artery, ligamentum arteriosum, superficial cardiac plexus, left recurrent nerve, left bronchus, bronchial glands.

Thoracic aorta : anterior, left pulmonary artery, left bronchus, pericardium, esophagus (below); *posterior*, vertebral column, vena azygos minor; *right side*, esophagus, vena azygos major, thoracic duct, right pleura and lung; *left side*, left pleura and lung, esophagus (below).

Describe the coronary arteries.

The *right* arises from the aorta above the free margin of the anterior semilunar valve, passes in the groove between the right auricle and ventricle to the posterior interventricular groove, where, dividing into two branches, one continues onward anastomosing with the left coronary, the other descends along the interventricular groove to the apex of the heart, anastomosing with the descending branch of the left coronary; the *left coronary*, the larger, arises above the free edge of the left posterior semilunar valve, passes forward between the pulmonary artery and the left appendix, thence obliquely to the anterior interventricular groove, where it divides, one branch passing around to join the right vessel, the other descending in the groove to anastomose at the apex with the descending branch of the right vessel.

Describe the innominate artery[4].

Arising from the commencement of the arch of the aorta, it is from one and a half to two inches long and bifurcates at the upper border of the right sterno-clavicular articulation into the right common carotid[5] and subclavian[6]; sometimes it sends off a *thyroidea ima* branch ; occasionally no innominate exists, the right carotid and subclavian springing directly from the aorta.

Relations of the innominate artery are: *in front*, sternum, sterno-hyoid and sterno-thyroid muscles, remains of the thymus gland, left innominate vein, right inferior thyroid vein, inferior cervical cardiac branch of the right pneumogastric nerve; *right side*, right innominate vein, right pneumogastric nerve, pleura; *left side*, remains of the thymus gland, left carotid artery, left inferior thyroid vein, trachea; *behind*, trachea.

Describe the common carotid^{5}**,**^{7}**.**

The *right common carotid artery*^{5} arises opposite the right sterno-clavicular joint from the innominate, the left from the summit of the aortic arch. In the neck their course corresponds to a line passing from the sterno-clavicular joint to a point midway between the mastoid process and the angle of the lower jaw; below, the trachea only separates them, above there is a wide interval; a common sheath of deep fascia encloses the internal jugular vein, the pneumogastric nerve (posterior to both) and artery, enumerated from *without inward*, while upon the sheath lies the branch of the first and second cervical nerves (descendens cervicalis).

The *anterior relations* of the vessel for the most of its course are the anterior margin of the sterno-cleido-mastoid muscle, while about its middle it is crossed by the omo-hyoid muscle, the anterior jugular and middle thyroid veins, while above the omo-hyoid muscle, the sterno-mastoid artery, and the superior thyroid vein cross it; at the lower part of the neck the right internal jugular vein diverges from the artery, but the left often crosses the lower part of the corresponding artery; it is also in relation *anteriorly* to the sterno-hyoid, sterno-thyroid, and platysma muscles, to the deep and superficial fasciæ and skin. *Internally* lie the trachea, the thyroid gland, recurrent laryngeal nerve, inferior thyroid artery, larynx, and pharynx. *Posteriorly* are the longus colli and rectus capitis anticus major muscles, sympathetic and recurrent laryngeal nerves, and inferior thyroid artery. Opposite the upper border of the thyroid cartilage each vessel divides into the *internal* and the *external carotid*. The common carotid arteries have no branches.

The *left common carotid artery* has, in addition to the above description, a *thoracic portion* which presents the following *relations: in front*, sterno-hyoid and sterno-thyroid muscles, left innominate vein, remains of the thymus gland; *behind*, trachea, esophagus, thoracic duct, left subclavian artery, its thoracic portion; *internally*, innominate artery, inferior thyroid veins, and remains of the thymus gland; *externally*, left pneumogastric nerve, left pleura and lung, and left subclavian artery.

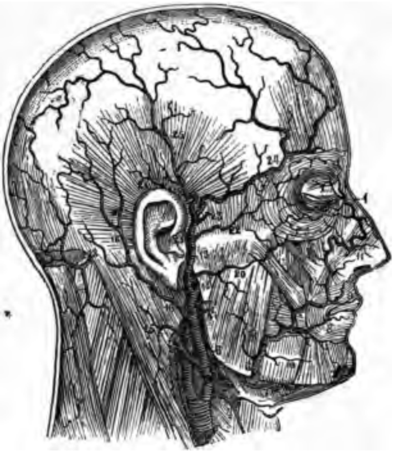


FIG. 103.—The arteries of the face and scalp (Leidy).

Name the branches of the external carotid artery, with their subdivisions.

1. *Superior thyroid*[4] (Fig. 103), arising below the greater cornu of the hyoid bone; its branches are:

Muscular,	Hyoid,	Superior laryngeal,
Superficial descending (sterno-mastoid),	Crico-thyroid.	

2. *Lingual* arises between the superior thyroid and the facial running beneath the hyoglossus muscle to the under surface of the tongue; its branches are:

Hyoid, Dorsalis linguæ, Sublingual, Ranine.

3. *Facial*[6] arises just above the lingual to cross the lower jaw just anterior to the masseter muscle; its branches are:

Cervical	Muscular,	Facial	Muscular[10],
	Inferior or ascending palatine,		Inferior labial[8],
	Tonsillar,		Inferior coronary[8],
	Submaxillary,		Superior coronary[9],
	Submental[7].		Lateralis nasi[11],
			Angular[12].

4. *Occipital*[13] arises posteriorly opposite the facial, lies in the occipital groove of the temporal bone; its branches are:

Muscular, Sterno-mastoid, Mastoid, Auricular,
Princeps cervicis, Meningeal, Terminal or Cranial.

5. *Posterior auricular*[16] arises opposite the styloid process, ascends beneath the parotid gland to the groove between the cartilage of the ear and the mastoid process; its branches are:

Muscular, Parotid, Stylo-mastoid,
Auricular, Mastoid or Occipital.

6. *Ascending pharyngeal*, running between the carotid and the side of the pharynx, its branches being very numerous and inconstant, and divided into three sets—

Pharyngeal, Meningeal, and Prevertebral.

7. *Superficial temporal*, terminal branch, commences in the substance of the parotid gland, crosses the root of the zygoma, two inches above which it divides into the *anterior*[24] and *posterior*[25] *temporal;* its other branches are:

Parotid, Articular, Masseteric, Anterior auricular,
Transverse facial[20], Middle temporal[23], and Orbital[22].

8. *Internal maxillary*[1], the larger terminal branch, passes inward at right angles to the carotid at the inner side of the neck of the condyle of the lower jaw; it is divided into three portions: (1) *maxillary*, (2) *pterygoid*, and (3) *spheno-maxillary* (Fig. 104):

(1) Deep auricular,
Tympanic,
Middle meningeal,
Small meningeal,
Inferior dental
- Mylo-hyoid,
- Incisor,
- Mental.

(2) Deep temporal { anterior, posterior,
Pterygoid,
Masseteric,
Buccal.
(3) Alveolar,
Infraorbital,
Superior or Descending palatine,
Vidian,
Pterygo-palatine,
Nasal or Spheno-palatine.

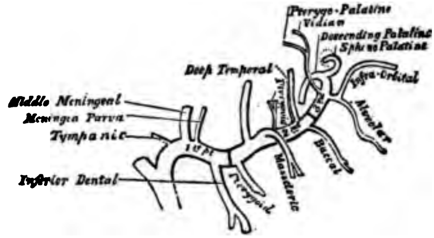


FIG. 104.—Plan of the branches of the internal maxillary artery (Gray).

Relations of the external carotid artery: antero-external, skin, superficial and deep fasciæ, platysma, anterior border of the sterno-mastoid, hypoglossal nerve, lingual and facial veins, posterior belly of the digastric and stylo-hyoid muscles, parotid gland with branches of the facial nerve, temporo-maxillary vein, lymphatic glands, and internal carotid artery; *posterior*, superior laryngeal nerve, stylo-glossus and stylo-pharyngeus muscles, glosso-pharyngeal nerve, pharyngeal branch of the pneumogastric, stylo-hyoid ligament and parotid gland; the latter six of this group separate the external from the internal carotid artery; *internal*, hyoid bone, pharynx, superior laryngeal nerve, parotid gland, ramus of the jaw, stylo-maxillary ligament.

Describe the internal carotid artery.

It runs in front of the transverse processes of the three upper cervical vertebræ in contact with the pharynx and tonsil to the carotid canal of the temporal bone, enters the skull, passes through the cavernous sinus and pierces the dura mater near the anterior clinoid process, where it divides into the *anterior* and the *middle cerebral arteries.*

Name its branches.

Tympanic (deep), from the artery in the carotid canal, anastomosing with the tympanic branch of the internal maxillary, stylo-mastoid, and Vidian arteries.

Arteriæ receptaculi, small vessels supplying the cavernous and inferior petrosal sinuses, pituitary body, and Gasserian ganglion; some to the dura mater anastomosing with the middle meningeal are called the *anterior meningeal.*

Ophthalmic, from the cavernous portion, enters the orbit by the optic foramen, dividing at the inner angle of the eye into two terminal divisions, the *frontal* and the *nasal;* its branches are:

Orbital group
- Lacrimal,
- Supraorbital,
- Posterior ethmoidal,
- Anterior ethmoidal,
- Palpebral,
- Frontal,
- Nasal.

Ocular group
- Muscular,
- Anterior ciliary,
- Short ciliary,
- Long ciliary,
- Arteria centralis retinæ.

Anterior cerebral passes forward in the great longitudinal cerebral fissure, and communicates with its fellow by the anterior communicating artery, a vessel about two lines long.

Middle cerebral, the largest branch, is lodged in the Sylvian fissure and divides into the *antero-lateral ganglionic branches*, which enter the anterior perforated space; the *external*, *inferior*, and *ascending frontal*, and the *ascending parietal*, supplying the parts indicated; the *parieto-temporal*, to the convolutions around the horizontal limb of the Sylvian fissure.

Anterior choroid, to the hippocampus major, corpus fimbriatum, velum interpositum, and choroid plexus.

Posterior communicating runs back to anastomose with the posterior cerebral, a branch of the basilar artery.

Describe the circle of Willis.

It consists of a vascular anastomosis at the base of the brain, between the branches of the carotids and basilar artery, whereby pressure on or blocking of any two of the main trunks will not prevent both sides of the brain from receiving a supply of blood. Its formation is as follows: the two vertebrals by their junction form the *basilar*, which divides into two *poste-*

rior cerebrals, these latter being connected with the back part of the internal carotids on each side by a *posterior communicating*, while the anterior terminals of the carotids, viz., the *anterior cerebral* on each side, are connected in front by the short *anterior communicating artery* before mentioned.

Describe the subclavian artery.

On the right side it springs from the innominate, on the left directly from the aortic arch. It is divided into *three portions*, viz., that internal to the anterior scalene muscle, that behind the muscle, and that external to the scalene, this muscle intervening between the artery and the subclavian vein; it ceases to be called subclavian at the lower border of the first rib, then being termed axillary. The branches arise from the first portion, except the right superior intercostal, which comes from the second; the posterior scapular or suprascapular often comes from the third portion.

Relations of the right subclavian artery: first portion; anterior, skin, superficial and deep fasciæ, platysma, clavicular origin of the sterno-mastoid, the sterno-hyoid, and sterno-thyroid muscles, beginning of right innominate vein, internal jugular and vertebral veins, pneumogastric, cardiac, and phrenic nerves; *posterior*, recurrent laryngeal nerve, sympathetic, apex of the lung and pleura, longus colli, neck of the first rib; *inferiorly* are the pleura and lung.

Second portion; anterior, skin, two layers of fascia, platysma, sterno-mastoid, phrenic nerve, scalenus anticus, subclavian vein; *posterior*, pleura, lung, and scalenus medius; *above* is the brachial plexus, and *below*, the pleura and lung.

Third portion; anterior, skin, two layers of fascia, platysma, descending branches of the cervical plexus, nerve to the subclavius, subclavius muscle, suprascapular artery and vein, external jugular and transverse cervical veins, clavicle; *behind* is the scalenus medius; *above* is the brachial plexus, omo-hyoid muscle; *below* is the posterior groove on the first rib.

Relations of the first portion of the left subclavian artery: in front, left pleura and lung, left carotid artery, left internal jugular, vertebral, and innominate veins, vagus, phrenic, and cardiac nerves; *superficially*, the sterno-hyoid, sterno-thyroid, and sterno-mastoid muscles; *internally*, trachea, esophagus, and thoracic duct; *externally*, pleura; *behind*, esophagus, thoracic duct, inferior cervical ganglion of the sympathetic, and the longus colli separating it from the vertebral column.

The *branches* are:

Vertebral, which passes through the foramina in the cervical transverse processes except that of the seventh, enters the skull through the foramen magnum, joining its fellow at the lower border of the pons Varolii to form the *basilar artery;* its branches are:

Cervical
- Lateral spinal,
- Muscular,
- Posterior meningeal.

Cranial
- Anterior spinal,
- Posterior spinal,
- Posterior inferior cerebellar.

Basilar, formed by the vertebrals, gives off the following:

Transverse,
Internal auditory,
Anterior,
Superior cerebellar,
Posterior cerebral,
Inferior cerebellar.

Thyroid axis divides almost at once into the

1. *Inferior thyroid*, to the same named gland, giving off the

Inferior laryngeal,
Tracheal,
Muscular,
Esophageal,
Ascending cervical.

2. *Suprascapular*, chiefly to the shoulder-joint and supraspinous fossa; it anastomoses with the acromio-thoracic, posterior circumflex, the posterior and subscapular arteries.

3. *Transversalis colli*, larger than the preceding, passes transversely outward to the trapezius, beneath which it divides into the

Superficial cervical,
Posterior scapular.

Internal mammary arises from the under surface of the first portion, opposite the thyroid axis, descends behind the costal cartilages half an inch from the sternum to the sixth interspace, where it divides into the *musculo-phrenic* and the *superior epigastric*, the latter anastomosing with the deep epigastric and its fellow; the branches are:

Superior phrenic, or
Comes nervi phrenici,
Mediastinal,
Pericardiac,
Sternal,
Anterior intercostal,
Perforating,
Lateral infracostal,
Musculo-phrenic,
Superior epigastric.

Superior intercostal passes in front of the neck of the first rib, giving off the *deep cervical*, and two *intercostals* which have *posterior muscular* and *spinal* branches.

Profunda cervicis supplies the posterior cervical muscles and anastomoses with the deep branch of the princeps cervicis from the occipital.

Describe the axillary artery.

It extends from the lower border of the first rib to the lower border of the tendon of the teres major muscle, where it takes the name of the brachial; it is divided into three parts by the crossing made by the pectoralis minor muscle.

Relations of the first portion: anterior, skin, two layers of fascia, platysma, pectoralis major, costo-coracoid membrane, external anterior thoracic nerve, acromio-thoracic and cephalic veins; *external*, brachial plexus; *internal*, axillary vein; *posterior*, first intercostal space, and intercostal muscle, second and part of third serrations of the serratus magnus, posterior thoracic, and internal anterior thoracic nerves.

Second portion: in front, integument, fasciæ, pectoralis major and minor; *external*, outer cord of the brachial plexus; *internal*, axillary vein, inner cord of the plexus; *behind*, subscapularis, posterior cord.

Third portion: anterior, integument, fasciæ, pectoralis major, inner head of the median nerve, outer brachial vena comes; *posterior*, subscapularis, tendons of the latissimus dorsi and teres major, musculo-spiral and circumflex nerves; *external*, coraco-brachialis, median and musculo-cutaneous nerves; *internal*, ulnar, internal cutaneous, and lesser internal cutaneous nerves, axillary vein.

The *first portion* is 2.5 cm. (1 inch) long, and gives off the superior thoracic branch; the *second portion* is 3 cm. (1⅕ inch) long, and gives off the acromio-thoracic and long thoracic; the *third portion* is 7.5 cm. (3 inches) long, and gives off the alar thoracic, subscapular, posterior circumflex, anterior circumflex, and often the accessory external mammary.

The branches are:

Superior thoracic, supplying the pectoral muscles and the thoracic wall.

Acromio-thoracic, supplying the deltoid by *acromial* branches, the serratus magnus and pectorales by the *thoracic*, the *descending*, or *humeral*, which runs with the cephalic vein between the deltoid and the pectoralis major, and the *clavicular* to the subclavius muscle.

Long thoracic (external mammary), to the chest-muscles and mammary gland.

Alar thoracic, supplies the axillary glands.

Subscapular, anastomosing with the supra and posterior scapular arteries, and giving off the *dorsalis scapulæ* branch.

Posterior circumflex, to the deltoid muscle and shoulder-joint; it anastomoses with the anterior circumflex, suprascapular, acromio-thoracic, and superior profunda arteries.

Anterior circumflex, to the shoulder-joint and deltoid.

Accessory external mammary, often is a branch from the third portion, runs downward and inward, and supplies the skin and fascia on the side of the thorax.

Describe the brachial artery.

A continuation of the axillary, extending from the lower border of the teres major tendon to its bifurcation into the radial and ulnar, usually opposite the neck of the radius; the median nerve crosses it from without inward about midway in its course.

Its *relations* are: *in front*, integument, fasciæ, bicipital fascia, median basilic vein, and median nerve; *externally*, vena comes, median nerve (above), coraco-brachialis, and biceps; *internally*, vena comes, internal cutaneous and ulnar nerves, median nerve (below), basilic vein; *behind*, middle and inner heads of the triceps, musculo-spiral nerve, superior profunda artery, insertion of the coraco-brachialis, brachialis anticus. Its branches enumerated from above downward are:

Superior profunda, descending with the musculo-spiral nerve, giving off a posterior articular branch, which anastomoses with the interosseous recurrent and anastomotica magna, while the anterior terminal twigs of the main trunk inosculate with the radial recurrent.

Medullary artery, to the humerus.

Inferior profunda, anastomosing with the posterior ulnar recurrent and anastomotica magna.

Anastomotica magna, anastomosing with the posterior articular of the superior profunda, inferior profunda, and posterior ulnar recurrent.

Muscular, to the arm-muscles; special ones to the biceps and deltoid.

Describe the radial artery.

It appears to be a continuation of the brachial, but is much smaller, extending from the bifurcation at the elbow along the radial side of the forearm to the wrist, where, winding around the thumb, it passes between the two heads of the first dorsal interosseous muscle to the palm, there inosculating with the deep or communicating branch of the ulnar to form the *deep palmar arch.*

Its *relations* are: *in front*, skin, fasciæ, supinator longus muscle; *internally*, pronator teres and flexor carpi radialis; *externally*, supinator longus, radial nerve; *behind*, tendon of the biceps, supinator brevis, flexor sublimis digitorum, pronator teres, flexor longus pollicis, pronator quadratus, radius.

The branches of the radial are in the

Forearm	Wrist
Radial recurrent,	Posterior carpal,
Muscular,	First dorsal interosseous,
Superficialis volæ,	Dorsales pollicis,
Anterior carpal.	Dorsalis indicis.

Hand

Princeps pollicis,
Radialis indicis,
Three superior perforating,
Three palmar interosseous,
Palmar recurrent.

The last three are branches from the deep palmar arch.

Describe the ulnar artery.

Larger than the preceding, it passes from the bifurcation obliquely inward to the middle of the forearm, thence runs along its ulnar border, across the annular ligament to the radial side of the pisiform bone, curving across the palm, where, either anastomosing with the superficialis volæ, princeps pollicis, or radialis indicis of the radial, it forms the

Superficial palmar arch, whose branches are the *four digitals.*

Relations: in front, fasciæ, superficial layer of the flexor muscles, median nerve; *internally*, flexor carpi ulnaris, ulnar nerve; *externally*, flexor sublimis digitorum; *behind*, brachialis anticus, flexor profundus digitorum.

The branches of the ulnar are in the

Forearm

- Anterior ulnar recurrent,
- Posterior ulnar recurrent,
- Common interosseous
  - Anterior interosseous .
    - Median,
    - Muscular,
    - Medullary to the radius,
    - Medullary to the ulna,
    - Anterior communicating,
    - Terminal.
  - Posterior interosseous .
- Muscular.

Wrist

Anterior carpal,
Posterior carpal.

Hand

Deep, or communicating branch,
Superficial palmar arch—four digitals.

Describe the thoracic aorta.

Commencing at the left side of the lower border of the fourth thoracic vertebra, it terminates at the aortic opening, in the diaphragm in front of the body of the last thoracic vertebra.

Relations: in front, left pulmonary artery, left bronchus, pericardium, esophagus (below); *right side*, esophagus, vena azygos major, thoracic duct; *left side*, left pleura and lung, esophagus (below); *behind*, vertebral column, vena azygos minor.

Its branches are visceral and parietal.

Pericardial, variable in number and origin, for the pericardium.

Bronchial, variable in number and origin, usually one right and two left, for the lung-tissue proper.

Esophageal, commonly numbering four to five, anastomosing around the esophagus with branches of the inferior thyroid, phrenic, and gastric arteries.

Posterior mediastinal, numerous and small to the glands, areolar tissue, and vertebral portion of the diaphragm.

Intercostals, usually nine on either side, each dividing into an anterior and a posterior branch, the former subdividing into two at the angle of the rib, one branch running in the groove at the lower border of the rib above, the other running along the upper border of the rib below, in front both anastomosing with the anterior intercostal branches of the internal mammary, with the thoracic branches of the axillary, with the epigastric, phrenic, and lumbar arteries; the posterior division supplies the vertebræ, spinal cord, dorsal muscles, and skin.

Subcostal, or the *twelfth thoracic artery*, passes along the lower border of the twelfth rib.

Describe the abdominal aorta.

It commences at the aortic opening of the diaphragm in front of the body of the last thoracic vertebra, whence descending a little to the left of the vertebral column it terminates on the body of the fourth lumbar vertebra by dividing into the common iliacs.

Relations: anterior, lesser omentum and stomach, Spigelian lobe of the liver, lower end of the esophagus, celiac axis and branches, inferior mesenteric, *spermatic* or *ovarian arteries*, *splenic vein* and *commencement of the vena portæ*, *left renal vein*, *aortic* and *solar plexuses*, *pancreas*, *preaortic duodenum*, small intestines, *mesentery*, *transverse mesocolon*, *lymphatic glands* and *vessels;* of the above the parts in *italics* are in contact with the aorta; *posterior*, left lumbar veins, left crus of the diaphragm, beginning of the thoracic duct, vertebral column; *right side*, right crus of the diaphragm, inferior vena cava, vena azygos major, thoracic duct, right semilunar ganglion, right great splanchnic nerve, Spigelian lobe of the liver; *left side*, left crus of the diaphragm, left great splanchnic nerve, left semilunar ganglion, tail of the pancreas.

Its branches are:

Celiac axis, arises opposite the margin of the diaphragm, passes for half an inch forward to divide into the

Gastric or *coronary*, passing upward to the left to the cardia; it turns sharply from the left to the right along the lesser curvature of the stomach, anastomosing with the aortic esophageal, splenic, and hepatic arteries.

Hepatic, dividing in the transverse fissure into the right and left terminal branches for the same lobes of the liver; its branches are—

- Pancreatic,
- Pyloric,
- Gastro-duodenalis
  - Gastro-epiploica dextra,
  - Pancreatico-duodenalis superior,
- Cystic,

whereby it supplies the parts indicated by the names, and anastomoses with the splenic, gastric, and superior mesenteric arteries.

Splenic, the largest branch, passes behind the upper border of the pancreas to the spleen, giving off five or six *splenic branches*, and the

Pancreaticæ parvæ,
Pancreatica magna,
Gastric (vasa brevia),
Gastro-epiploica sinistra.

Inferior phrenic, one on each side (sometimes one from the celiac axis instead of the aorta, or by a common trunk) to the under surface of the diaphragm. Each gives off a *superior suprarenal* artery.

Superior mesenteric comes off about one-quarter inch below the celiac axis, arching forward and downward to the left, supplying all of the small intestine, except the first part of the duodenum, also the cecum, ascending, and transverse colon, giving off the

Inferior pancreatico-duodenal,
Vasa intestini tenuis,
Ileo-colic,
Colica dextra,
Colica media.

Inferior mesenteric, arising from the left side of the aorta two inches above the bifurcation, passes down into the left iliac fossa and pelvis, supplying the descending colon, sigmoid flexure, and greater part of the rectum, anastomosing above with the middle colic of the superior mesenteric, supplying the transverse colon in part; its branches are:

Colica sinistra, Sigmoid, Superior hemorrhoidal.

Middle suprarenal, each arises opposite the superior mesenteric to supply the suprarenal body.

Renal, spring nearly at right angles from the sides of the aorta below the superior mesenteric, the right longer and lower than the left; each divides into four or five branches before entering the hilum, intervening between the renal vein in *front* and the ureter *behind* and *below*. It gives off the *inferior suprarenal artery*, making three for that body.

Spermatic (ovarian in the female), spring from the front of the aorta on each side, a little below the renals, run behind the peritoneum to pass in the *male* through the abdominal ring to the testis, in the *female* between the laminæ of the broad ligament to the ovary, Fallopian tube, uterus, and to the round ligament and inguinal canal.

Lumbar, commonly four on each side corresponding to the intercostals, and like them dividing into:

Dorsal branches to the vertebræ, spinal cord, and back muscles, and *abdominal* branches, passing forward to anastomose with twigs from the epigastric, internal mammary, intercostals, ilio-lumbar, and circumflex iliac.

Middle sacral, springs from the bifurcation of the aorta, descends along the middle of the sacrum and coccyx, sending branches to the rectum, anastomosing with the hemorrhoidal and lateral sacral arteries, terminating in the *coccygeal gland.*

Describe the common iliac arteries.

They extend from the aortic bifurcation at the left of the umbilicus, corresponding to a line touching the highest points of the iliac crests, to divide opposite the intervertebral disk between the last lumbar vertebra and the sacrum, into the *internal* and the *external iliac;* the right vessel is somewhat the longer, both being about two inches long, and each at its bifurcation is crossed by the ureter.

Relations of the right common iliac: in front, peritoneum, small intestine, sympathetic nerves, ureter; *outer side*, vena cava, right common iliac vein, psoas muscle; *behind*, two last lumbar vertebræ, right and left common iliac veins.

Relations of the left common iliac: in front, same as for the right, with the superior hemorrhoidal artery added; *inner side*, left common iliac vein; *outer side*, psoas muscle; *behind*, two last lumbar vertebræ, left common iliac vein.

Describe the internal iliac artery.

It measures about one and a half inches, arising at the point of bifurcation of the common iliac, to divide at the upper margin of the great sacro-sciatic foramen into the *anterior* and the *posterior trunk.* In the adult it is smaller than the external, the reverse in the fetus. A partially obliterated cord, the fetal *hypogastric artery*, extends from its bifurcation to the bladder.

Relations: in front, peritoneum, ureter; *outer side*, psoas magnus; *inner side*, internal iliac vein, peritoneum; *behind*, external iliac vein (above), internal iliac vein, lumbo-sacral nerve, sacrum.

Branches of the anterior division: Superior vesical, part of the fetal hypogastric artery; it gives off the *artery* of the *vas deferens* and supplies the ureter, as well as the bladder.

Middle vesical, usually a branch of the former to the bladder and vesiculæ seminales.

Inferior vesical (vaginal in the female), arising in common with the middle hemorrhoidal, is distributed to the base of the bladder, prostate gland, and seminal vesicles.

Middle hemorrhoidal, supplies the rectum.

Uterine, anastomoses with the ovarian; gives twigs to the bladder and ureter.

Obturator, passes through the obturator canal to the thigh, there dividing into an internal and an external branch, anastomosing with twigs of the internal circumflex; inside the pelvis its branches are:

Iliac, to the same named bone and muscle anastomosing with the ilio-lumbar; a *vesical*, to the bladder; and a *pubic*, inosculating back of the pubes with the epigastric and its fellow; in two out of three cases the obturator springs from the internal iliac, in one in three and a half cases from the epigastric, in one in seventy-two cases it has two roots.

Internal pudic, the smaller terminal of the anterior division, is distributed to the external organs of generation; giving off the following branches:

Inferior hemorrhoidal,
Superficial perineal,
Transverse perineal,
Muscular,
Artery of the bulb,
Artery of the corpus cavernosum,
Dorsal artery of the penis.

Sciatic, the larger terminal, supplies the muscles on the back of the pelvis; its branches are:

Muscular,
Inferior gluteal,
Coccygeal,
Anastomotic,
Comes nervi ischiadici,
Cutaneous,
Articular (hip).

Branches of the posterior division: Ilio-lumbar, dividing into an *iliac* and a *lumbar branch* supplying the muscular, spinal, and nutrient branches, anastomosing with the last lumbar, external circumflex, gluteal, epigastrics, deep circumflex iliac, and obturator.

Lateral sacral, *superior* and *inferior* on each side emerge from the posterior sacral foramina, anastomosing with the gluteal and sciatic arteries.

Gluteal ends the posterior division, divides into a *superficial* and a *deep branch*, the latter giving off a superior and an inferior branch.

It has *muscular*, *cutaneous*, *nutrient* (to the ilium), and *articular branches*, anastomosing with the circumflex iliac, external circumflex, and sciatic arteries.

Describe the external iliac artery.

Passes along the inner border of the psoas muscle from the bifurcation of the common iliac to Poupart's ligament; a line drawn from the left side of the umbilicus to the midpoint between the symphysis pubis and the anterior superior iliac spine (in females a little nearer the former), indicates the course of the common and external iliac.

Relations: in front, peritoneum, intestines, and fascia, lymphatic vessels and glands; near Poupart's ligament are the spermatic vessels, genital branch of the genito-crural nerve, deep circumflex iliac vein; *externally*, psoas magnus, iliac fascia; *internally*, external iliac vein and vas deferens; *behind*, external iliac vein, psoas magnus, iliac fascia.

Its branches are:

Muscular,
Deep epigastric,
Lymphatic (to glands),
Deep circumflex iliac.

Deep epigastric, usually coming off just above Poupart's ligament, passing between the peritoneum and transversalis fascia, pierces the fascia and enters the sheath of the rectus muscle under the semilunar fold of Douglas; it anastomoses with the internal mammary and inferior intercostal arteries; its branches are:

Cremasteric, Pubic, Muscular, Superficial.

Deep circumflex iliac, arises externally nearly opposite the epigastric, running along the inner side of the iliac crest, there to pierce the transversalis and anastomose with the ilio-lumbar and gluteal arteries. An ascending branch joins the lumbar and epigastric arteries.

Describe the femoral artery (Fig. 105).

Extending from Poupart's ligament, where the letters N. A. V. indicate its relation with the anterior crural nerve and femoral vein, it terminates at the opening in the adductor magnus (the end of Hunter's canal); the upper two-thirds of a line drawn from the midpoint between the anterior superior iliac spine and symphysis pubis to the inner side of the internal condyle of the femur indicates its course. The artery and vein are enclosed in a strong fibrous sheath, but separated by a partition from each other, and lie very superficially above, in Scarpa's triangle, bisecting it.

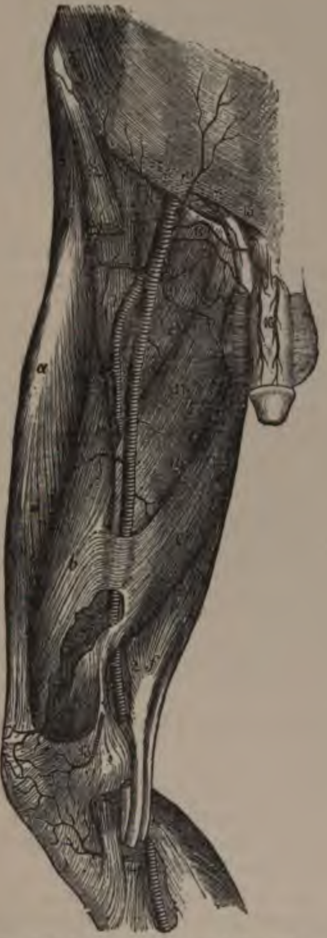
The femoral artery has three parts: *common femoral* is one to two inches long, dividing into the *superficial* and the *deep femoral* (*profunda femoris*).

What is Scarpa's triangle?

It is a space bounded above by Poupart's ligament, internally by the outer edge of the adductor longus, externally by the inner edge of the sartorius, the floor being formed by the iliac, psoas, pectineus, and part of the adductor brevis muscles.

Relations of the common femoral artery: anterior, skin, superficial fascia, superficial inguinal glands, iliac portion of the fascia lata, anterior part of the femoral sheath from the transversalis fascia, crural branch of the genito-crural nerve, superficial circumflex iliac and superficial epigastric veins; *posterior*, posterior part of the femoral sheath from the iliac fascia, pubic portion of the fascia lata, nerve to the pectineus, psoas muscle and tendon, pectineus, capsule of the hip-joint; *internal*, femoral vein; *external*, anterior crural nerve and psoas muscle.

Relations of the superficial femoral artery in Scarpa's tri-



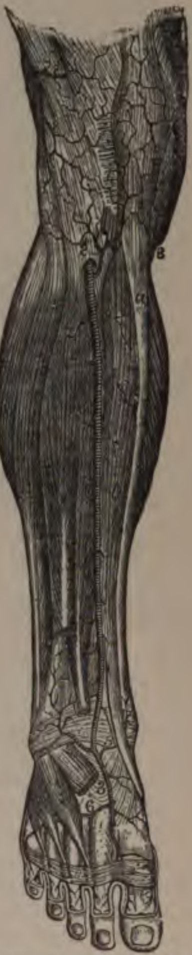


FIG. 105.—The femoral artery and the side-view of the popliteal artery. (Leidy.)

FIG. 106.—The anterior tibial and the dorsalis pedis arteries.

angle and Hunter's canal: anterior, skin, superficial and deep fasciæ, internal cutaneous and saphenous nerves, sartorius, aponeurotic covering of Hunter's canal; *posterior*, femoral vein, profunda artery and vein, pectineus, adductor longus and magnus muscles; *external*, long saphenous nerve, nerves to the vastus internus, vastus internus muscle, and femoral vein; *internal*, adductor longus, magnus, and sartorius muscles.

The femoral artery gives off the following branches:

Superficial epigastric[4], to the inguinal glands, fascia, and skin, anastomosing with the superficial branches of the deep epigastric.

Superficial circumflex iliac[5], to the skin of the groin, glands etc., anastomosing with the deep circumflex, iliac, gluteal, and external circumflex arteries.

Superior external pudic[6], to the skin of the genitals, anastomosing with the terminal branches of the internal pudic, its fellow, the inferior pudic, and the cremasteric arteries.

Inferior external pudic[6], to the skin of the genitals and perineum, anastomosing with the superficial perineal and superior external pudic arteries.

Muscular[11], to the sartorius and vastus internus.

Anastomotica magna[12], arises just above Hunter's canal, and divides into a superficial (cutaneous) and a deep branch, anastomosing with the internal and superior external articular, and the anterior tibial recurrent arteries[14].

Profunda femoris[7], springing from the outer back part of the femoral from one to two inches below Poupart's ligament, terminating at the lower third of the thigh by the small fourth perforating artery; it gives off:

External[8] and Internal Circumflex[9]. Four perforating[10].

Describe the popliteal artery.

It commences at the opening in the adductor magnus, and passing obliquely downward and outward behind the knee-joint, divides opposite the lower border of the popliteus muscle into the *anterior* and the *posterior tibial arteries.*

Relations: in the upper part of the popliteal space, the three chief structures are arranged from behind forward and without inward in a certain order; first comes the internal popliteal nerve, next the popliteal vein, deepest and most internal the popliteal artery; *anterior*, are the femur, posterior ligaments of the knee-joint, a bit of the head of the tibia, popliteal fascia, and muscle; *posterior*, skin, fasciæ, semimembranosus, popliteal vein, internal popliteal nerve, sometimes a twig from the obturator nerve, inner head of the gastrocnemius, plantaris, arch of the soleus; *internal*, semimembranosus, adductor magnus tendon, internal condyle, inner head of the gastrocnemius, internal popliteal nerve (below), popliteal vein (below); *external*, biceps, outer condyle, outer head of the gastrocnemius, plantaris, internal popliteal nerve (above), popliteal vein (above). Its branches are:

Superior muscular,
Inferior muscular or sural,
Cutaneous,
Azygos articular,
Superior external articular,
Superior internal articular,
Inferior internal articular,
Inferior external articular.

These anastomose with the perforating terminal branch of the profunda, descending branch of the external circumflex, anastomotica magna, anterior tibial recurrent, and with each other, except the muscular; the azygos articular enters the back of the joint to supply the synovial membrane and interarticular ligaments.

Describe the anterior tibial artery (Fig. 106).

Commencing at the lower border of the popliteus muscle, passing between the two heads of the tibialis posticus by the defect at the upper part of the interosseous membrane, lying upon its anterior surface and that of the lower third of the tibia, it terminates at the front of the bend of the ankle in the *dorsalis pedis artery;* the anterior tibial nerve lies externally; *branches* are the *posterior* and *anterior tibial recurrent*, *superior fibular*, *muscular*, *internal* and *external malleolar;* the posterior recurrent and superior fibular rise from the artery before it pierces the membrane.

Relations: in front, skin, fasciæ, anterior tibial nerve, tibialis anticus, extensor longus digitorum, extensor longus hallucis, anterior annular ligament; *internally*, tibialis anticus, extensor longus hallucis; *externally*, anterior tibial nerve, extensor longus digitorum, extensor longus hallucis; *behind*, interosseous membrane, tibia, anterior ligament of the ankle-joint.

Describe the dorsalis pedis artery[5].

It extends from the front of the bend of the ankle to the back part of the first intermetatarsal space, where it divides into the *first dorsal interosseous*[7] (dorsalis hallucis), supplying both sides of the great toe and adjoining side of the second; the *plantar digital branch* (communicating), dipping down between the heads of the first dorsal interosseous muscle to reach the sole of the foot, and form with the external plantar the plantar arch ; it gives off *two digital branches*, one for the inner side of the great toe and one which divides for the contiguous sides of the great and second toes; the other branches are the

Tarsal, arching outward across the tarsus.

Metatarsal[6], runs anterior to the preceding over the bases of the metacarpal bones, giving off the second, third, and fourth *dorsal interosseous*, from which arise *seven dorsal digitals* for the outer three and a half toes. This artery lies upon the astragalus, navicular, and middle cuneiform bones, and is crossed by the innermost tendon of the extensor brevis digitorum.

Describe the posterior tibial artery.

It extends as a large vessel obliquely downward from the lower border of the popliteus muscle along the tibial side of the leg to the midpoint of the depression between the inner ankle and heel, where, beneath the abductor hallucis muscle, it divides into the internal and the external plantar; the posterior tibial nerve lies first to its inner side, but soon crosses it, to remain close to the outer side; it gives off the

Peroneal, along the back of the fibular side of the leg, *branches* of which are *muscular*, *medullary* to the fibula, *communicating*, *anterior peroneal*, *posterior peroneal*, and *external calcaneal.* The anterior peroneal anastomoses with the external malleolar, tarsal, and posterior peroneal arteries. The peroneal artery is enveloped by the flexor longus hallucis muscle.

The posterior tibial also gives off *muscular branches*, *medullary* to the tibia, *cutaneous*, *communicating*, and *internal malleolar; internal calcaneal* usually come from the external plantar.

Communicating, to the peroneal, passing transversely across the back of the tibia about two inches above the ankle.

Relations: in front, tibialis posticus, flexor longus digitorum, tibia, ankle-joint; *internally*, posterior tibial nerve (upper third); *externally*, posterior tibial nerve (lower **two-**

thirds); *behind*, skin, fasciæ, gastrocnemius, soleus, deep transverse fascia, posterior tibial nerve.

Describe the internal plantar artery.

The smaller terminal of the posterior tibial runs along the inner side of the foot and great toe, giving off *muscular*, *cutaneous*, and *articular branches.*

Describe the external plantar artery.

It passes obliquely outward and forward to the base of the fifth metatarsal, whence it curves inward to the interval between the bases of the first and second metatarsal bones, there anastomosing with the plantar digital branch of the dorsalis pedis, completing the *plantar arch;* the branches given off in its *course to the fifth metatarsal bone* are the *internal calcaneal*, *muscular*, and *cutaneous.*

Internal calcaneal, several large branches to the inner muscles of the sole, fat and skin of the heel, anastomosing with the peroneal, internal malleolar, and external calcaneal.

The branches of the *plantar arch* are:

Three posterior perforating, passing up the three outer intermetatarsal spaces to anastomose with the interosseous from the metatarsal.

Four digitals, by division supplying both sides of the three outer toes, and the outer side of the second—both sides of the great and the inner side of the second toe being supplied by the plantar digital branch of the dorsalis pedis.

The digitals give off *three anterior perforating* arteries near their bifurcations into the *collateral digitals.*

Surgical Anatomy of the Arteries.

The student must remember that while all the anastomosing vessels coming off above and below the site of ligature enlarge, and should, therefore, be carefully impressed upon the mind where enumerated in the preceding pages, yet the blood, by dissection, has been found to pass chiefly by the vessels mentioned under each caption.

Describe the collateral circulation after ligature of the common carotid.

The chief communications are between the superior and inferior thyroids, the profunda cervicis of the subclavian, and princeps cervicis of the occipital, the vertebral taking the place of the internal carotid within the cranium.

After ligature of the subclavian (third part).

Between the suprascapular and the posterior scapular with the subscapular, the internal mammary, and the long and superior thoracic and subscapular.

After ligature of the axillary.

If below the acromio-thoracic, chiefly between the subscapular and the other scapular arteries of the subclavian and long thoracic, through the intercostals with the internal mammary; if below the subscapular, the posterior circumflex anastomosing with the suprascapular and acromio-thoracic, and inosculations between the subscapular and the superior profunda.

After ligature of the brachial.

(1) Upper third, by anastomoses between the circumflex and subscapular and superior profunda; (2) below the profunda arteries, by branches of the profundæ anastomosing with the recurrents of the ulnar, radial, and interosseous arteries.

When the thoracic aorta is obliterated.

The internal mammary anastomosing with the intercostals; phrenic with the musculo-phrenic, comes nervi phrenici and deep epigastric, superior intercostal and first aortic intercostal; inferior thyroid with the first aortic intercostal; transversalis colli with the posterior branches of the intercostals; axillary and subclavian branches to the side of the chest with the lateral branches of the intercostals.

When the abdominal aorta is tied.

The deep epigastric communicating with the internal mammary, the intercommunications of the superior and inferior mesenteric, or the latter with the internal pudic, and the anastomoses of the lumbar with the branches of the internal iliac.

After the common iliac is tied.

The anastomosis of hemorrhoidal branches of the internal iliac with the superior hemorrhoidal from the inferior mesenteric, the inosculations of the uterine and ovarian, and of the vesicals of opposite sides, that of the lateral sacral with the middle sacral, of the epigastric with the internal mammary, intercostal and lumbar, of the ilio-lumbar with the last lumbar, of the obturators with one another and the deep epigastrics, of the gluteal with the lateral sacral branches.

After the internal iliac is tied.

Same as above, except that the obturator also communicates with the internal circumflex, the circumflex and perforating branches of the profunda with the sciatic, and the circumflex iliac with the ilio-lumbar and gluteal.

After the external iliac is tied.

The anastomoses between the ilio-lumbar and the circumflex iliac; the gluteal and external circumflex; the obturator and internal circumflex; the sciatic with the superior perforating and the two circumflex arteries; the internal pudic with the external pudic and internal circumflex.

After the common femoral is tied.

Anastomoses of gluteal and circumflex iliac with the external circumflex; obturator and sciatic with internal circumflex; ilio-lumbar with the external circumflex; comes nervi ischiadici with the muscular branches of the popliteal.

After the superficial femoral is tied.

Branches from the profunda anastomosing with the superior and inferior articular of the knee, anastomotica magna, muscular, and origins of the anterior and posterior tibial.

(The popliteal is never tied except for a wound, when the articular arteries, anastomotica magna, recurrent tibials, perforating and muscular branches would convey the blood.)

The Veins.

Describe the veins.

They are vessels returning venous blood—*i. e.* blood surcharged with carbonic acid gas—to the heart, and have the same coats as arteries, but not so thick, especially the middle, in consequence collapsing when divided. One set of veins only carries other than venous blood, viz. the pulmonary conveying arterial blood from the lungs to the left auricle. Certain of the veins, usually the superficial, have their lining membrane forming semilunar reduplications or valves, arranged in pairs opposite one another, which prevent any reflux of blood. The large arteries are accompanied by deep veins of the same name, generally included in the same sheath, while such vessels as the brachial, radial, ulnar, etc. have two veins each, called *venæ comites*. The superficial veins run between the layers of the superficial fascia, terminating in the deep veins, and are not usually accompanied by arteries. All veins freely anastomose, and even those dignified with special names have very irregular origins and distributions.

What are sinuses?

Venous channels, found only within the skull, formed by a separation of the layers of the dura mater, and lined with endothelium continuous with that of the veins.

How are the veins classed?

As belonging to the *pulmonary*, *systemic*, and *portal systems*, the latter an appendage of the systemic.

Name the principal veins which have no valves.

The venæ cavæ, hepatic, portal, renal, uterine, ovarian, cerebral, spinal, and pulmonary.

Name the veins of the head and neck.

(1) Frontal,
Supraorbital,
Angular,
Facial,
Temporal,
Internal maxillary,
Temporo-maxillary,
Posterior auricular,
Occipital.

(2) Those which return the blood from the head and face:
External jugular,
Posterior external jugular,
Anterior jugular,
Internal jugular,
Vertebral.

(3) Veins of the cranium:
Veins of the diploë,
Cerebellar,
Cerebral { Superficial, and
Deep, or Venæ Galeni.

Name the sinuses of the dura mater.

Above and behind, one *superior* and one *inferior longitudinal*, *straight*, two *lateral*, two *occipital;* at the base are two *cavernous*, *circular*, *transverse*, two *superior* and two *inferior petrosal.*

Eight or nine *emissary veins of Santorini* afford communication between the sinuses of the dura and the external veins by the following foramina : *mastoid*, *parietal*, *posterior condylar*, through the *external occipital protuberance*, *foramen ovale*, *foramen lacerum*, *foramen Vesalii*, *carotid canal*, *anterior condylar foramina*.

How is the internal jugular[7] formed (Fig. 107) ?

By the junction of the lateral and inferior petrosal sinuses just outside the jugular foramen ; at the base of the neck the internal jugular unites with the subclavian vein to form the innominate vein—at or above the junction is a pair of valves ; into the jugular empty the common facial, lingual, pharyngeal, superior and middle thyroid veins.

Where do the following veins empty?

The *external jugular*[8], into the subclavian vein external to the internal jugular ; the *posterior external jugular*, into the external jugular ; the *anterior jugular*, into the termination of the external jugular or the subclavian vein ; the *vertebral* descends through the vertebral foramina in the transverse processes of the cervical vertebræ to empty into the back of the innominate vein, valves guarding the orifice.

Describe the veins of the upper extremity.

They are superficial and deep, the latter being the *venæ comites* of the arteries ; commencing as *digitals*, these empty into the *interosseous*, these into the *palmar* until the *radial* and *ulnar comites* are formed, which, uniting, form the *brachial venæ comites*, consisting of two veins with transverse anastomoses. The superficial veins running in the superficial fascia are called :

Radial		*Cephalic*	*Axillary*
Median	*Median cephalic* *Median basilic*	*Brachial*	
Anterior and *Posterior ulnar*		*Basilic*	

Describe the axillary vein.

It is a continuation of the basilic, receiving the brachial and veins of corresponding names with the arteries of the axilla, and is continued beneath the clavicle under the name of the *subclavian vein*[9] ; it has valves opposite the lower border of the subscapular muscle, also at the mouths of the cephalic and subscapular veins.

Describe the subclavian vein[9].

It extends from the lower border of the first rib to the back of the sterno-clavicular joint, there uniting with the internal jugular to form the vena innominata—the subclavian vein lies in *front* of the artery with the scalenus anticus muscle interposed at its second part; its tributaries are the external and the anterior jugular and a tributary of the cephalic; on the right side the *right lymphatic duct* empties at the junction of the subclavian and internal jugular veins, and at the same point on the left side the *thoracic duct.*

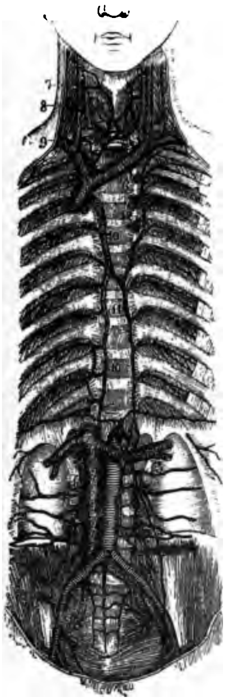


FIG. 107.—The venæ cavæ and azygos veins (Leidy).

How are the venæ innominatæ[5,6] formed?

Each by the subclavian and internal jugular, which unite just below the first costal cartilage to form the superior vena cava[4]; the *right innominate* is about one and a half inches long, receiving blood by the right vertebral, internal mammary, inferior thyroid, often the right superior intercostal vein; the *left vein* is larger and about two and one-half inches long; the left vertebral, internal mammary, inferior thyroid, superior intercostal, and occasionally some thymic and pericardiac veins empty into it.

Describe the superior vena cava[4].

It measures from two and a half to three inches and is formed by the union of the two innominate veins[5,6], is half covered by the pericardium and enters the upper part of the right auricle; it returns the blood of the upper half of the body and receives the vena azygos major and small mediastinal and pericardiac veins.

Describe the azygos veins.

They connect the superior and the inferior venæ cavæ, taking the place of those vessels in that part of the chest occupied by the heart.

The *right azygos*[10] (vena azygos major) commences opposite the first and second lumbar vertebræ by a tributary from the right lumbar or renal vein, or from the inferior vena cava, enters the thorax by the aortic opening, passes to the level of the fifth rib, and arches over the root of the right lung to empty into the superior cava, receiving in its course the nine or ten right lower intercostal veins, the vena azygos minor, esophageal, mediastinal, and right bronchial veins; also it is usually connected with the right superior intercostal vein.

The *left lower azygos*[11] (vena azygos minor) commences by a tributary from the left lumbar or renal vein, enters the thorax through the left crus of the diaphragm, passes across from the left side of the vertebral column at about the ninth thoracic vertebra to enter the right azygos vein, receiving veins from three or four lower intercostal spaces, also mediastinal and esophageal tributaries.

The *left upper azygos*[12] is formed by veins, usually three or four, from the intercostal spaces between the left superior intercostal and the highest branch of the left lower azygos—*i. e.* from the fourth space to the seventh or eighth inclusive—and empties into the right azygos or left lower azygos; it receives mediastinal tributaries and the left bronchial vein; it is sometimes absent, its place being taken by the left superior intercostal.

Name the other principal veins of the base of the neck anc of the thorax.

Internal mammary,	*Mediastinal,*
Inferior thyroid,	*Pericardiac,*
Intercostals,	*Bronchial.*

Briefly describe the spinal veins.

They are the *dorsi-spinal* on the exterior of the spinal column, forming plexuses around the vertebral spines, laminæ, and processes, emptying into the vertebral, intercostal, lumbar, and sacral veins respectively.

The *meningo-rachidian*, lying between the vertebræ and theca spinalis, forming plexuses, one running along the posterior surfaces of the vertebral bodies, forming two *anterior longitudinal veins* receiving the venæ basis vertebrarum, the other on the inner surfaces of the laminæ, forming two *posterior longitudinal veins*, both extending the whole length of the spinal canal; the posterior emptying into the dorsi-spinal, the anterior into the vertebral, intercostal, lumbar, and sacral veins respectively.

The *venæ basis vertebrarum* lie in the vertebral bodies and empty into the anterior longitudinal veins.

The *medulli-spinal*, those of the cord itself, form a minute plexus over the cord between the pia mater and the arachnoid, and near the base of the skull converge to form two or three trunks terminating in the inferior cerebellar veins or petrosal sinuses.

Describe the chief veins of the lower extremity.

They are deep and superficial; the former commence as the venæ comites of the *digitals*, which form the *interosseous;* these form the *anterior*, *posterior tibial*, and *peroneal comites* of the same named arteries, which uniting, form the *popliteal*, in the thigh to be called the *femoral*, being joined by the *profunda femoris* and the *internal saphenous veins*, which again changes its name to the *external iliac* above Poupart's ligament; into the external iliac empty the deep epigastric and deep circumflex iliac veins.

The superficial veins are the

Internal or *long saphenous*, commencing on the inner side of the dorsum of the foot, running up in front of the inner malleolus on the inside of the leg and thigh to enter the femoral vein after passing through the saphenous opening of the fascia lata; its tributaries are:

Cutaneous,
Communicating,
Superficial epigastric,
Superficial circumflex iliac,
External pudic,
Anterior and *posterior vein.*

External or *short saphenous* commences at the outer side of the dorsum of the foot, passes behind the external malleolus, and up the middle of the leg posteriorly to empty into the popliteal vein between the heads of the gastrocnemius.

Describe the internal iliac vein.

It is formed by the venæ comites of all branches of the internal iliac artery except the umbilical, and unites opposite the sacro-iliac articulation with the external iliac vein to form the common iliac vein; it receives the following veins:

Gluteal,
Sciatic,
Dorsal vein of penis or *clitoris*,
Internal pudic,
Obturator,
Lateral sacral,
Uterine and *vaginal plexuses*, in female,
Vesico-prostatic plexus, in male,
Hemorrhoidal plexus.

The portal and general venous systems meet in the hemorrhoidal plexus.

Describe the common iliac veins.

Formed by the junction of the external and internal iliac veins, and receiving the ilio-lumbar, occasionally the lateral sacral, the *left iliac* receiving the middle sacral vein, they unite at an angle upon the intervertebral substance between the fourth and fifth lumbar vertebræ to form the inferior vena cava.

Describe the inferior vena cava[1].

It runs upward from the junction of the two common iliacs, along the right side of the aorta, grooves the liver, pierces the central tendon of the diaphragm, and terminates at the back and lower part of the right auricle, being enclosed by the serous layer of the pericardium; it returns the blood from all parts below the diaphragm, and receives the following tributaries:

Lumbar,
Right spermatic,
Right ovarian,
Renal[2,3]
Right suprarenal,
Inferior phrenic,
Hepatic,
Right common iliac,
Left common iliac.

Describe the portal system of veins.

Formed by the union behind the head of the pancreas of the *superior* and *inferior mesenteric*, *splenic*, and *gastric veins*, collecting the blood from the viscera of digestion; the resulting *portal vein* divides in the transverse fissure of the liver into a branch each for the right and left lobe, which ramify to form a *venous plexus* in the liver-tissue; the hepatic artery sends branches within the liver to the portal vein, and external to the organ the vein receives the pyloric and the coronary veins; the portal blood is returned to the inferior vena cava by the *hepatic veins.*

Name the cardiac veins.

Anterior or *great cardiac vein,*
Middle cardiac vein,
Left or *posterior cardiac veins,*
Right or *anterior cardiac veins,*
Right or *small coronary sinus,*
Left or *great coronary sinus,*
Venæ Thebesii.

What is the coronary sinus?

A dilatation of about one inch of the anterior cardiac vein in the posterior part of the left auriculo-ventricular groove, covered by the left auricle, receiving the posterior and middle cardiac veins, right sinus, and an oblique vein of Marshall from the back of the left auricle; its cardiac orifice is guarded by the coronary valve.

Describe the pulmonary veins.

Commencing in the lung capillaries they form a main vein for each lobule, which unite into two trunks for each lung, opening separately into the left auricle; at times there are three veins on the right side, or the two left may terminate by a common opening.

The Lymphatics.

What are the lymphatics?

Delicate vessels with transparent walls formed of the same three coats as the arteries and found in all parts of the body probably, except the nails, cuticle, hair, and cartilage; they have numerous valves, producing their characteristic beaded appearance; they are supplied with nutrient arteries, but not with nerves.

What are the lacteals?

The lymphatics of the small intestine, conveying *chyle during digestion, lymph* at other times.

Describe the lymphatic glands.

They are small, solid, round, or oval glandular bodies, situated in the course of the absorbent vessels which previous to enter ing a gland break up into several *afferent vessels*, form a plexus within, and emerge by several *efferent vessels* which soon unite to form a single trunk; each gland is surrounded by a fibrous capsule which sends partitions inward, forming alveoli in which lies the gland-pulp, or *lymphoid tissue*, consisting of a rete whose meshes are filled with lymph-cells. The glands are chiefly found in the mesentery, along the great vessels, in the mediastinum, axilla, neck, at the front of the elbow, groin, and popliteal space, being usually named from their locality, as axillary or inguinal.

Describe the thoracic duct.

This conveys the bulk of the lymph and chyle into the blood, being the common lymph-trunk except for the right upper extremity, right side of the head, neck, and thorax, right lung, right side of the heart, and convexity of the liver. It commences (sometimes) by the triangular *receptaculum chyli*, on the front of the body of the second lumbar vertebra, enters the thorax by the aortic opening, crosses behind the aorta at the fourth thoracic vertebra, and opposite the upper border of the seventh cervical vertebra it curves downward to empty into the junction of the left internal jugular and subclavian veins. It is from fifteen to eighteen inches long in the adult.

Describe the right lymphatic duct.

It is about one inch long, receiving lymph from those parts *excepted* in the account of the thoracic duct. and empties at the junction of the right internal jugular and subclavian veins; both ducts have double semilunar valves at their orifices, preventing regurgitation of blood.

THE NERVOUS SYSTEM.

What are the two divisions of the nervous system?

The *cerebro-spinal*, or that presiding over animal life, and the *sympathetic*, that regulating organic life.

Describe the structure of nerve-tissue.

It is composed chiefly of two structures: the *gray* or *vesicular*, originating impulses and receiving impressions; and the *white* or *fibrous*, conducting impressions; in the sympathetic system is found a third structure, *gelatinous nerve-tissue;* 75 per cent. of nerve-tissue is composed of water, the remainder being albumin, phosphorized fat, and salts.

Describe the microscopic structure of white nerve-tissue.

It is formed of tubular fibers, each consisting of a central *axis-cylinder*, surrounded by the *white substance of Schwann*, the whole enclosed by the *tubular membrane* or *primitive sheath.* A bundle of these fibers invested by a fibro-areolar membrane, the *perineurium* (neurilemma), constitutes a *nerve*, receiving a special blood-supply by the *vasa nervorum;* the *gelatinous* variety consists of finely granular fibrillæ enclosed in a sheath —by some these are not considered to be nerves.

Describe gray or vesicular nerve-tissue.

This consists of large granular cells containing nuclei and nucleoli, ovoid, or with one or many processes (*unipolar*, *multipolar*), some of which become continuous with an axis-cylinder.

How do nerves terminate?

Peripherally sensory nerves end in minute plexuses, end-bulbs, tactile corpuscles, and Pacinian corpuscles; in the special organs they end in cells and in other not well-ascertained ways; motor nerves end peripherally in plexuses or by "*motorial end-plates.*" The central terminations are not well understood.

What organs compose the cerebro-spinal system?

The brain, spinal cord, and the cranial and spinal nerves.

The membranes of the spinal cord and brain are the dura mater, the arachnoid, and pia mater.

Describe the cerebral dura mater with its processes.

It is a dense fibrous membrane lining the interior of the skull, constituting the internal periosteum, is continuous with that of the spinal cord, and is prolonged to the outer surface of the skull through the various foramina; by separation of its layers the cerebral sinuses are formed; its smooth under surface is covered with endothelial cells; its processes, three in number, are the

Falx cerebri, a sickle-shaped layer occupying the longitudinal fissure of the brain; along the upper and lower border respectively run the superior and inferior longitudinal sinuses.

Tentorium cerebelli, covering the upper surface of the cerebellum; it supports the weight of the posterior lobes of the cerebrum; it is attached to the horizontal arms of the occipital cross, enclosing the lateral sinuses, to the upper margins of the petrous bones, including the superior petrosal sinuses, whence it extends to the anterior and posterior clinoid processes; to the mid-line above the falx cerebri is attached antero-posteriorly, and below medianly is the base of the

Falx cerebelli, a small triangular process passing vertically between the cerebellar lobes behind.

What are the Pacchionian bodies?

Numerous aggregations of small whitish granulations of unknown function found upon the outer surface of the dura mater near the superior longitudinal sinus, lying in depressions in the bone, in the superior longitudinal sinus, on the inner surface of the dura, and on the pia mater; unknown in infancy, rare before the third year; they are enlargements of normal villi of the arachnoid.

Describe the arachnoid.

It is a delicate membrane lying between the pia mater and the dura mater, being separated from the latter by the *subdural space;* it bridges over the convolutions, forming *part of the subarachnoidean space*, and at the base, by being stretched between the middle lobes, the *anterior subarachnoidean space* is left; while between the cerebellar hemisphere and the medulla oblongata lies the *posterior subarachnoidean space*, the two communicating across the crura cerebri, and by an opening in its lower boundary with the fourth ventricle; these spaces contain the cerebro-spinal fluid, forming an elastic water-cushion for the encephalon: it consists of interwoven bundles of fibrous and yellow elastic tissue covered with a layer of endothelium.

What is the pia mater?

It consists of a minute plexus of blood-vessels derived from the internal carotid and vertebral arteries, held together by fine areolar tissue; it dips between the convolutions, helps to form the velum interpositum and choroid plexuses of the third and fourth ventricles, and contains nerves and lymphatics.

The Brain.

The cerebral part of the cerebro-spinal system includes the medulla oblongata, pons Varolii, cerebellum, and cerebrum. The upper end of the neural tube develops into three *primary vesicles;* next the anterior and posterior vesicles subdivide and five *secondary vesicles* result, each having a cavity and special derivatives.

The brain should be described in its five parts :

1. Anterior primary vesicle, or forebrain	First secondary vesicle (*prosencephalon*)	Anterior end of the third ventricle, foramina of Monro, lateral ventricles, cerebral hemispheres, olfactory bulbs and tracts, corpora striata, corpus callosum, fornix.	
	Second secondary vesicle (*thalamencephalon*)	Third ventricle, optic nerves and retinæ, optic thalami, pituitary and pineal bodies.	
2. Middle primary vesicle, or midbrain	Third secondary vesicle (*mesencephalon*)	Aqueduct of Sylvius, corpora quadrigemina, crura cerebri.	
3. Posterior primary vesicle, or hindbrain	Fourth secondary vesicle (*epencephalon*)	Fourth ventricle	Cerebellum. Pons.
	Fifth secondary vesicle (*metencephalon*)		Medulla oblongata.

What is the weight of the brain?

Forty-nine and a half ounces, on the average, in males, and forty-four ounces in females; heaviest male brain recorded, sixty-eight and three-eighths ounces; lightest, thirty-four ounces; female brain, heaviest fifty-six ounces, lightest thirty-one ounces; idiots' brains seldom weigh more than twenty-three ounces.

Name the fissures and lobes of the cerebrum (Fig. 108).

Each half, or *hemisphere*, has its external surface subdivided into five lobes by three fissures:

Fissure of Sylvius, beginning at the anterior perforated space, passes to the external surface of the hemisphere and subdivides: one arm *ascends* toward the frontal lobe, and one passes nearly *horizontally* backward into the parietal lobe.

The *fissure of Rolando* commences at or near the middle of the longitudinal fissure, running downward and forward to a point a little above the horizontal branch of the Sylvian fissure.

The *external parieto-occipital fissure* commences about midway between the posterior extremity of the brain and fissure of Rolando, running downward and forward for a few millimeters.

The *frontal lobe* lies in front of the fissure of Rolando, and above the ascending part of the Sylvian fissure; it has three surfaces; its under surface is called the *orbital lobe*.

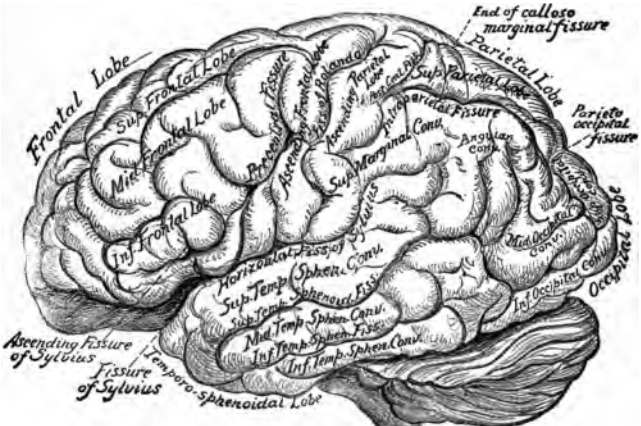


FIG. 108.—Convolutions and fissures of the outer surface of the cerebral hemisphere.

The *parietal lobe* is bounded in front by the fissure of Rolando, behind by the external parieto-occipital fissure, and below by the horizontal limb of the Sylvian fissure.

The *occipital lobe* lies behind the external parieto-occipital fissure.

The *temporo-sphenoidal lobe* occupies the middle cerebral fossa of the skull, and is limited above and in front by the Sylvian fissure.

The *central lobe,* or island of Reil, lies in the fissure of Sylvius at the base of the brain; the lobes overlapping it are called *opercula.*

The inner or median surface of each hemisphere presents five fissures and about nine gyri or convolutions:

The *calloso-marginal fissure* (Fig. 109), separating the marginal convolution from the gyrus fornicatus.

The *internal parieto-occipital fissure,* a continuation of the external on the outer surface of the hemisphere.

The *calcarine fissure* runs from the back of the hemisphere horizontally forward to the postero-inferior extremity of the gyrus fornicatus; it is joined by the internal parieto-occipital fissure.

The *collateral fissure* runs below and nearly parallel to the preceding, separated by the infracalcarine or fifth temporal gyrus.

The *dentate fissure* commences below the posterior extremity of the corpus callosum, running forward to end at the recurved part of the hippocampal gyrus, the *uncus.* It separates the dentate gyrus from the hippocampal gyrus.

The *transverse fissure,* between the temporal lobes and crura cerebri, fornix, and optic thalami, admits the pia mater into the lateral ventricles.

Mention the principal convolutions of the brain.

The convolutions, or *gyri,* are elevated ridges covered with gray matter, separated by deep furrows, or *sulci,* thus securing a great extent of gray matter; while not uniform in all brains, nor symmetrical, certain principal convolutions are constant, such as

The *gyrus fornicatus,* that lying over the corpus callosum.

The *marginal,* forming the antero-superior margin of the great longitudinal fissure on the mesial surface of the hemisphere.

The *uncinate gyrus* includes the hippocampal and infracalcarine gyri

The *limbic lobe* nearly forms a ring around the corpus callosum, its ends being separated by the anterior perforated space; the structures forming it are the gyrus fornicatus, hippocampal gyrus, peduncles of the corpus callosum, fascia dentata, fornix, the anterior and posterior pillars of the fornix, and one layer of the septum lucidum. Its boundaries are the calloso-marginal, collateral, and post-limbic fissures.

The *ascending frontal* (Fig. 108), forming the anterior boundary of the fissure of Rolando.

The *ascending parietal*, at the posterior boundary of the same fissure.

The *angular gyrus* is a part of the inferior parietal convolution, curving around the extremity of the superior temporal sulcus.

The *supramarginal gyrus* lies behind the lower end of the intraparietal sulcus, arching over the posterior extremity of the fissure of Sylvius.

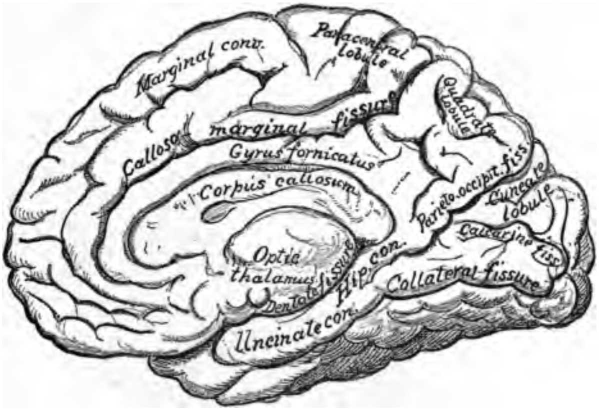


FIG. 109.—Convolutions and fissures of the inner surface of the cerebral hemisphere.

Other convolutions are indicated by the names on the diagrams.

Where are the quadrate, cuneate, and paracentral lobes (Fig. 109)?

The former is on the mesial surface between the calloso-marginal fissure in front and the internal parieto-occipital behind; the *cuneate* lies between the parieto-occipital and the calcarine fissures; the *paracentral* is on the mesial surface around the upper end of the fissure of Rolando.

Mention structures seen on the under surface of the brain, in the middle line, and on each side.

Longitudinal fissure[1] (Fig. 110), partially separating the hemispheres.

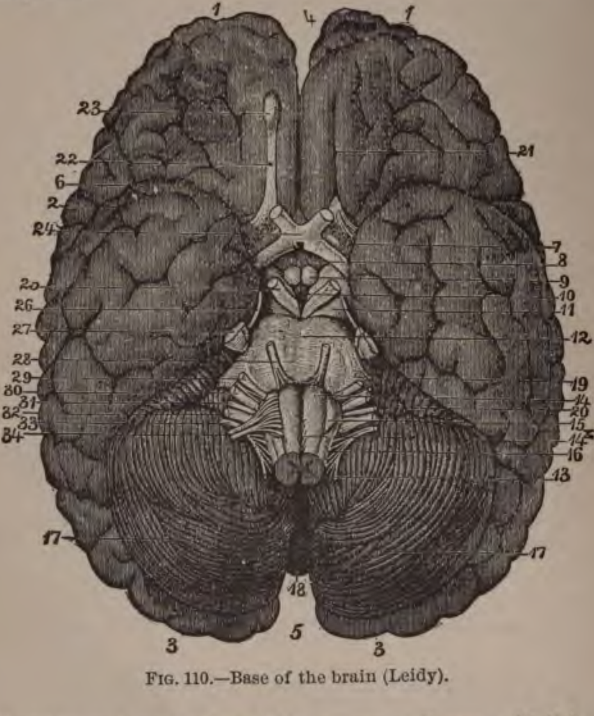


FIG. 110.—Base of the brain (Leidy).

Rostrum and peduncles of the corpus callosum, which is the transverse commissure connecting the cerebral hemispheres.

Lamina cinerea passes forward from the tuber cinereum over the optic chiasma, turns upward anterior to the third ventricle as the *lamina terminalis*, and joins the anterior end of the corpus callosum. The angle at the upward bend is the *optic recess.*

Optic commissure[24], union of the optic tracts, with their partial decussation.

Tuber cinereum, an eminence of the gray matter, part of the floor of the third ventricle.

Infundibulum[8], a hollow conical process of the gray matter projecting from the middle of the under surface of the tuber cinereum, communicating with the third ventricle, joining the posterior lobe of the pituitary body.

Pituitary body, a vascular, two-lobed body projecting from the apex of the infundibulum into the sella turcica of the sphenoid.

Corpora albicantia[9], are two rounded terminations of the anterior crura of the fornix, and of the columns of Vicq d'Azyr from the optic thalami.

Posterior perforated space[10], between the corpora albicantia in front, the pons Varolii behind, and the cerebral crura on either side, forms part of the floor of the third ventricle, and gives passage for vessels to the optic thalami. It is the anterior part of the substantia nigra.

Tuber annulare of the pons[12] and the ventral surface of the *medulla* follow.

Laterally are seen the *frontal lobe*, *olfactory bulb*, *tract*, *roots*, and the *optic tract.*

Fissure of Sylvius[4], separating by its horizontal limb the frontal and the parietal lobes from the temporo-sphenoidal; its ascending limb passes upward into the inferior frontal convolution.

Anterior perforated space[7], between the roots of the olfactory nerve on each side for the passage of vessels into the corpus striatum.

Crus cerebri[11] (*peduncle of the cerebrum*) connects the cerebrum with the cerebellum, medulla oblongata, and spinal cord.

Then follow the lower surfaces of the *temporal lobe* and of the *cerebellum.*

Name and describe the basal ganglia of the hemispheres.

They are near the island of Reil and form the oldest part of the brain. They consist of the *corpora striata*, the *claustra*, and *amygdaloid nuclei*, the *optic thalami* belonging to the thalamencephalon, *tænia semicircularis*, *external* and *internal capsules*, and *anterior commissure*.

Corpora striata, chief part of the motor tract, lying in the lateral ventricles, the intraventricular gray portion called the *caudate nucleus*, the extraventricular, the *lenticular nucleus*, the *internal capsule* dividing the two.

The *lenticular nucleus* is bounded externally by the *external capsule*, and that externally by the gray matter called the *claustrum*. The *caudate nucleus* runs downward and forward in the roof of the descending cornu, and terminates in the *nucleus amygdalæ* in the apex of the temporal lobe.

Each *optic thalamus* has two rounded extremities, the *anterior* and the *posterior tubercles*, the latter being called *pulvinar*, and four surfaces; the *inferior surface* rests on the tegmentum of the crus cerebri; the *external* is in contact with the internal capsule; the *internal* forms the lateral boundary of the third ventricle; the *upper surface* presents a groove for the margin of the fornix; the part external to the groove is on the floor of the body of the lateral ventricle; the part internal is covered by the velum interpositum. Posteriorly are the *external* and *internal geniculate bodies*.

The *tænia semicircularis* lies in a depression between the nucleus caudatus and the optic thalamus. In front it joins the anterior pillar of the fornix; behind, it enters the nucleus amygdalæ.

What is the internal capsule?

A large tract of white matter belonging to the pyramidal tract, consisting of two limbs, the *anterior*, lying between the anterior part of the lenticular nucleus and the caudate nucleus, and the *posterior*, lying between the posterior part of the lenticular nucleus and the optic thalamus, which, by their junction, form a projection inward, the *knee* or *genu*.

What is the external capsule?

A small tract of white matter lying between the outer part of the lenticular nucleus and the claustrum.

What are the commissures?

Connecting bands of white or gray matter. Those of white matter have three sets—1, *projection-fibers*, which pass from the mid-brain to the hemispheres and form the corona radiata;

2, *transverse* or *commissural*, connecting the hemispheres; 3, *association-fibers*, on one side of the middle line, which may connect near or distant parts; short and long fibers are present, The long fibers are the

Superior longitudinal fasciculus,
Inferior longitudinal fasciculus,
Perpendicular fasciculus,
Uncinate fasciculus,
Fillet of the gyrus fornicatus, or *Cingulum*,
Fornix.

Other longitudinal bands may be mentioned, not properly association-fibers—olfactory tracts, tænia semicircularis, crura cerebri, peduncles of the pineal gland, superior peduncles of the cerebellum, gyrus fornicatus.

The *transverse fibers* of the white matter are two in number —1, *transverse fibers of the corpus callosum;* 2, *anterior commissure.* In addition are the middle, posterior, and optic commissures, pons, and fornix.

What are the ventricles of the brain?

Five serous cavities, four of which intercommunicate; they are *two lateral*, a *third*, a *fourth*, and a *fifth*.

Describe the lateral ventricles.

The *corpus callosum* roofs them in; each has a *body*, an *anterior cornu*, curving outward and forward into the frontal lobe, a *middle cornu* passing into the temporal lobe *b*ackward, *o*utward, *d*ownward, *f*orward, and *i*nward (*bodfi*), containing the curved *hippocampus major*, and a *posterior cornu* curving backward and inward into the occipital lobe, containing the *hippocampus minor;* the floor from before backward is formed by the *corpus striatum*, *tænia semicircularis*, *optic thalamus*, *choroid plexus*, *corpus fimbriatum*, half of the *body* and the *posterior pillar of the fornix.* The septum lucidum is internal.

What are the pes hippocampi and the pes accessorius?

The former consists of elevations of the lower extremity of the hippocampus major in the floor of the descending cornu.

Pes accessorius, or *eminentia collateralis*, is a white eminence external to the hippocampus major; it is near the junction of the middle and the posterior horns, and is formed by the internal projection of the collateral fissure.

What is the fascia dentata?

It is a free edge of the gray substance of the dentate convolution, seen by raising the edge of the corpus fimbriatum.

Describe the following parts.

Olfactory bulbs[23], the ganglia of the sense of smell, lie in the olfactory grooves of the cribriform plate of the ethmoid, and arise by two white roots: the *outer* root crosses the fissure of Sylvius coming from a nucleus of gray matter in the hippocampal gyrus; the *inner* root comes from the lower end of the gyrus fornicatus; and the *middle* or gray root comes from the under surface of the same lobe.

The *corpus callosum* is a thick arched layer of transverse fibers at the bottom of the longitudinal fissure, anteriorly curving upon itself, giving off two peduncles to the entrance of the Sylvian fissure; posteriorly is the *splenium* continuous with the fornix; a median linear depression on its upper surface is called the *raphé*, parallel to which on each side run two or more elevated longitudinal bands, the *striæ longitudinales* or *nerves of Lancisi.*

Choroid plexus is the vascular margin of the velum interpositum, communicating with that of the opposite side just behind the anterior pillars of the fornix, through the *foramina of Monro;* posteriorly, it descends into the middle horn, becoming there continuous with the pia mater through the transverse fissure.

Corpus fimbriatum (*tænia hippocampi*) is the lateral edge of the posterior pillar of the fornix, forming a white band just behind the choroid plexus; it is attached to the hippocampus major and ends at the uncus.

The *fornix*, continuous with the corpus callosum behind, consists of two halves forming a triangular *body*, two *anterior pillars*, curving downward to the base of the brain, there to end in the *corpora albicantia* and not in the optic thalami, and two *posterior pillars*, running down the middle cornua of the lateral ventricles, joining the *hippocampi majores* and *fimbriæ;* on the back under surface of the corpus callosum, between the posterior pillars of the fornix, certain transverse, longitudinal, and oblique lines have been termed the *lyra.*

The *septum lucidum* is a vertical septum, attached above to the under surface of the corpus callosum, below to the anterior part of the fornix and prolonged portion of the corpus callosum; it is triangular in form, and consists of two laminæ of white nerve-matter lined internally with gray matter, the space between forming the *fifth ventricle*, not communicating with the other ventricles.

Describe the corpora quadrigemina.

These are four rounded projections placed just behind the third ventricle and the posterior commissure, beneath the posterior border of the corpus callosum, resting on the lamina quadrigemina, beneath which in the median line is the aqueduct of Sylvius. Two white bands on each side connect them with the *geniculate bodies* and *optic tract;* that passing from an anterior quadrigeminal tubercle, the *anterior brachium*, goes between the *internal geniculate body* and the posterior extremity of the optic thalamus to the *external geniculate body* and thence to the optic tract. The *posterior brachium* passes from a posterior quadrigeminal tubercle and loses itself under the internal geniculate body. These tubercles seem to be connected with the cerebellum by the superior peduncles, which pass to the optic thalami through the tegmenta of the crura.

What is the valve of Vieussens?

A thin lamina of nerve-tissue, stretching from the vermiform process of the cerebellum from one superior peduncle to the other, forming the roof of the upper half of the fourth ventricle; a little ridge descending upon the upper part from the corpora quadrigemina is the *frænulum*, and on either side is the fourth nerve; on the upper surface is a grooved lobule of gray matter—the *lingula.*

What is the pineal gland?

It is a small reddish body, *epiphysis cerebri*, behind the posterior commissure, above and between the upper pair of corpora quadrigemina; it is attached on each side by a *stalk* made of a *dorsal* and a *ventral lamina* separated by the *pineal recess:* the former belongs to the posterior commissure; the latter is prolonged as the *stria pinealis* to the anterior pillar of the fornix. Laterally the stalk merges into the *trigonum habenulæ*, a depression on the upper surface of the optic thalamus.

Describe the third ventricle.

Narrow and oblong, the lateral walls being the optic thalami and peduncles of the pineal gland; above, the under surface of the velum interpositum roofs it in, containing the choroid plexuses of this ventricle; the lamina cinerea, tuber cinereum, infundibulum, corpora albicantia, posterior perforated space, and tegmenta form its floor; it is limited in front by the anterior crura of the fornix and the lamina cinerea; behind, by the posterior commissure, beneath which opens the aqueduct of Sylvius; while in front, by the foramina of Monro, it communicates with the lateral ventricles; the cavity is crossed by an anterior and a posterior *white commissure* and by a middle *gray commissure.*

Describe the fourth ventricle.

It is the space between the posterior surface of the medulla oblongata and the pons in front and the cerebellum behind. Its *roof* is the *superior medullary velum* or valve of Vieussens, the *tent* and the *inferior medullary velum;* the *lateral boundaries* on each side are above, the superior peduncle of the cerebellum, below, the clava of the funiculus gracilis, funiculus cuneatus, and restiform body; the *floor* is diamond-shaped, made of two triangles, the lower belongs to the medulla, the upper to the pons; below it is continuous with the central canal of the cord, above, with the aqueduct of Sylvius; on each side is a *lateral recess;* the lower end is called the *calamus scriptorius*, and the edge of epithelium on the margins is the *ligula*, and at the calamus is the *obex.* The floor is bisected by a median groove, from the middle part of which arise the *striæ medullares*, running transversely outward. Below them are three triangles on each side: internally the *trigonum hypoglossi*, or *fasciculus teres;* externally the *trigonum acustici*, its base pointing upward; and between these the *trigonum vagi* with its apex above. This apex is the *inferior fovea;* the floor and base are the *ala cinerea* and the *eminentia cinerea;* from it arise the ninth, tenth, and eleventh cranial nerves. Above the striæ is the *superior fovea*, to its inner side is the fasciculus teres continued; above the fovea is a groove, the *locus cœruleus*—the color is due to the presence of pigmented nerve-cells, the *substantia ferruginea.*

Describe the pons Varolii.

It is the ventral portion of the *hind-brain*, the cerebellum being the dorsal; it connects the medulla below with the crura cerebri. It is about one inch long; its width is a little greater; it is three-fourths of an inch thick. It has four surfaces, the *superior* and the *inferior* seen after section, the *ventral* and the *dorsal;* the dorsal forms the upper half of the floor of the fourth ventricle; the ventral surface rests on the dorsum sellæ and is grooved by the basilar artery; it shows well-marked transverse fibers, which are the *middle peduncles of the cerebellum*, or the *tuber annulare.* The pons has gray matter and four sets of white fibers, transverse and longitudinal, with superficial and deep sets in each. The gray matter contains the *nuclei pontis*, *superior olivary nucleus*, *nucleus of the seventh*, *two nuclei of the fifth*, and *nuclei of the auditory* and *sixth nerves.*

Describe the medulla oblongata.

The *medulla* or *spinal bulb* is the *after-brain* connecting the spinal cord with the pons Varolii and cerebellum. It lies in the vallecula between the cerebellar hemispheres and rests on the basilar groove of the occipital bone. It is about one inch long, three-quarters of an inch wide, and three-fifths of an inch thick; it has two extremities and four surfaces. It is divided into symmetrical lateral halves by the *anterior* and *posterior median fissures* (Figs. 110 and 111). Each lateral surface is marked off by a *dorso-lateral* and a *ventro-lateral groove.*

The lower half of the *ventral surface* is made up of the *crossed pyramidal tracts* of the cord, *decussation of the pyramids*, and laterally by the *direct pyramidal tracts.* Above, in the upper half, are the two *pyramids;* behind each pyramid is the ventro-lateral groove.

The *lateral surface* presents, above, the *olivary body* with its *dentate nucleus;* below is the *lateral tract*, containing the *antero-lateral ground bundle*, *antero-lateral ascending* and *descending cerebellar tracts* of the cord. *Superficial arciform fibers* wind back over this surface.

The *dorsal surface* is divided below by the posterior median fissure and separated from the lateral tract by the dorso-lateral groove; it receives the *direct cerebellar tract* of the cord passing into the *restiform body.* Three columns are between this tract and the median fissure: externally is the *funiculus of Rolando;* next, the *funiculus cuneatus;* innermost, the *funiculus gracilis.* The upper half of the dorsal surface is the lower half of the floor of the fourth ventricle, bounded laterally by the restiform bodies, which are the *inferior peduncles of the cerebellum.*

Describe the cerebellum.

It is that portion of the *hind-brain* contained in the inferior occipital fossæ composed of *laminæ* covered with gray matter; in the middle line is the *worm*, laterally are two *hemispheres.* It is four inches wide, two inches long, and about two inches thick; it weighs five ounces; its proportion to the cerebrum is as 1 to 8¾. Above is a median ridge, the *superior vermiform process;* below is a median fossa, the *vallecula*, containing the *inferior vermiform process.* In front and behind is a notch, the *incisura cerebelli*, *anterior* and *posterior;* the *great horizontal fissure* surrounds the cerebellum.

Describe the lobes and sulci of the cerebellum.

	Hemisphere.		Worm.	Worm and Hemisphere.
Sulcus precentralis	Frænulum lingulæ.		Lingula.	Lobus lingulæ.
Sulcus postcentralis	Ala lobuli centralis.		Lobulus centralis.	Lobus centralis.
Sulcus preclivalis	Lobus lunatus anterior (crescentic).		Culmen monticuli.	Lobus culminis.
Sulcus postclivalis	Lobus lunatus posterior (crescentic).		Clivus monticuli.	Lobus clivi.
Sulcus horizontalis magnus	Lobus postero-superior.		Folium cacuminis.	Lobus cacuminis.
Sulcus postgracilis	Lobus semilunaris inferior.	Lobus postero-inferior.	Tuber valvulæ.	Lobus tuberis.
Sulcus intragracilis	Lobulus gracilis posterior.			
Sulcus pregracilis, s. postpyramidalis	Lobulus gracilis anterior.			
Sulcus prepyramidalis	Lobus biventralis (digastric).		Pyramis.	Lobus pyramidis.
Sulcus postnodularis	Amygdala (tonsil).		Uvula.	Lobus uvulæ.
	Flocculus.		Nodulus.	Lobus noduli.

The surfaces of the cerebellum present *lobes* and *interlobular fissures;* the upper surface has five lobes and four fissures; from before backward, on the *superior worm*, they are the *lingula*, *lobulus centralis*, *culmen*, *clivis*, and *folium cacuminis;* corresponding lobes of the hemisphere are the *frænulum*, *ala*, *anterior* and *posterior crescentic*, and *postero-superior*. The *interlobular fissures* are the *precentral*, *postcentral*, *preclival*, and *postclival*. On the lower surface are four lobes and three fissures; from behind forward on the *inferior worm* are the *tuber valvulæ*, *pyramis*, *uvula*, and *nodulus;* on the hemisphere are the *postero-inferior*, divisible into the inferior semilunar, posterior and anterior slender, the *biventral* or *digastric*, the *amygdala*, and the *flocculus*. The *fissures* are the *postpyramidal*, *prepyramidal*, and *postnodular*. The complete arrangement is a combination of three lobes, one on each hemisphere and one on the worm, separated from similar groups by fissures.

How many peduncles has the cerebellum?

Three: the transverse fibers of the pons Varolii, or *middle peduncle;* on each side the restiform bodies of the medulla oblongata, or *inferior peduncles;* the *superior peduncles* run to the corpora quadrigemina, and help to form the roof of the fourth ventricle, the valve of Vieussens lying between.

Describe the arrangement of the gray matter of the cerebellum.

A vertical section reveals a central stem of white matter containing a pouch of gray matter, the *corpus dentatum*. From the central white stem ten or twelve plates, or *laminæ*, spring, covered externally by a layer of gray matter, so that the cut surface presents the appearance called *arbor vitæ*. Special nuclei are the *nucleus emboliformis*, *globosus*, *fastigii*, or *nucleus of the roof*.

Cranial Topography.

Certain important advances have recently been made in cerebral surgery; the student of anatomy should note some of the contributing causes, such as the localization of brain-centers and their relations to cranial surfaces. Certain *guide-points* are agreed upon, as the *glabella*, the smooth eminence between the ridges for the eyebrows; *nasion*, the center of the naso-frontal suture; *inion*, the external occipital protuberance; *lambda*, at the superior angle of the occipital bone, 6 cm. (nearly 2½ inches) above the inion; *orbital arch*, *external angular process*, *mastoid process*, *external auditory meatus*, *superior nuchal* (curved) *line*, *parietal eminence*, *zygoma*, *sutures*, are all used as landmarks.

The *middle meningeal artery* is opposite a point in the temporal fossa at equal distances, one inch, one and a half, or two inches above the zygoma and the same distance behind the external angular process of the frontal bone.

The *mastoid antrum* and site of operation on the same is one-third to one-half inch behind, and the same distance above the center of the external auditory meatus.

Fissure of Rolando: draw a line from the naso-frontal groove, nasion, to the inion; a point taken on this line 1 cm. (½ inch) behind its center, or 55.6 per cent. of the distance from the glabella, will indicate the *superior Rolandic point.* Draw the *Rolandic line* downward and forward for a distance of 8.6 cm. (3⅜ inches), at a *Rolandic angle* of 71.5° with the mesial line, often given as 67°, but it varies from 64° to 75°. If the inion cannot be easily felt, the upper end of the Rolandic line may be practically found by measuring back from the nasion 18 cm. in case of large heads, 17 cm. in small ones. The fissure of Rolando is not quite so long as the Rolandic line, and the ends of the fissure do not quite correspond with the superior and the lower Rolandic points. The *precentral* and *postcentral sulci* are nearly parallel with this fissure, and 15 mm. distant.

Another method is Reid's: he first marks the longitudinal fissure and horizontal limb of the fissure of Sylvius; *Reid's base-line* passes from the infraorbital margin, and is continued through the middle of the external auditory meatus; it is horizontal; from it are drawn two perpendicular lines to the top of the cranium; one from the *preauricular point*, which is a depression between the tragus of the ear and the condyle of the jaw, and one from the posterior border of the base of the mastoid process. A four-sided figure is thus formed and a diagonal from its postero-superior angle downward to the anterior perpendicular line where it crosses the fissure of Sylvius will represent the fissure of Rolando.

The *superior Rolandic point* may be found, of course, by the first method, and only one vertical line of Reid, the preauricular, be used to determine the *lower Rolandic point.*

The *fissure of Sylvius* (Reid's description) may be marked by a line drawn from a point one and one-fourth inches behind the external angular process of the frontal bone to a point three-fourths of an inch below the most prominent part of the parietal eminence; the first three-fourths of an inch represents the main fissure, and the rest the horizontal limb; the bifurcation of the fissure is therefore two inches behind and slightly above the level of the external angular process.

Another description (Quain) differs somewhat from the above in regard to measurements: carry a horizontal line backward from the fronto-malar junction (external angular process) for 35 mm. (1⅜ inches), and from the outer end of this draw a vertical line upward for 12 mm. (½ inch); the upper end of the latter marks the *Sylvian point*, the bifurcation of the Sylvian fissure; it lies under the posterior part of the spheno-parietal suture. A straight line drawn from the fronto-malar junction through the Sylvian point goes to the lower part of the parietal eminence and about overlies the *posterior limb* of the fissure; it is called the *Sylvian line.* The *ascending limb* is marked by a line 2 cm. long, starting from the Sylvian point directed upward and forward, at a right angle to the Sylvian line, crossing the coronal suture obliquely; the undivided *main fissure* passes horizontally forward beneath the spheno-parietal suture in the region of the pterion.

The *lower Rolandic point* is on the Sylvian line, 25 mm. behind the Sylvian point; it is 5.5 cm. (4 to 7 cm.) above the zygoma and on the vertical preauricular line. The fissure of Rolando ends about 1 cm. above this spot.

The *parallel fissure* of the temporo-sphenoidal lobe is indicated by a line drawn from the marginal tubercle on the postero-superior border of the malar bone to the lambda.

The *parieto-occipital fissure* is one-fifth of an inch above the lambda, or 6.5 cm. (more than 2½ inches) above the inion; draw a transverse line of 2 cm. to represent it.

The Spinal Cord.

What is the spinal cord?

The elongated cylindrical part of the cerebro-spinal axis contained in the vertebral canal, measuring sixteen and one-fourth to seventeen and one-half inches in length, extending from the lower margin of the foramen magnum to the lower border of the first lumbar vertebra, presenting a *cervical enlargement* from the third cervical to the first or second thoracic vertebra, and a *lumbar enlargement* opposite the two or three last thoracic vertebræ; it becomes the *conus medullaris* and ends by a filament, *filum terminale.* The white matter is disposed externally, the gray internally in the form of two crescents joined by a transverse commissure, the anterior thicker extremities forming the *anterior cornua*, or *horns*, the posterior forming the *posterior cornua.*

Describe the membranes of the cord.

Three: the *dura mater*, continuous with that of the brain, but separated from the bony walls by loose areolar tissue, containing a plexus of veins; the *arachnoid*, continuous with the cerebral arachnoid, also having a *subdural* and a *subarachnoidean* space, the latter communicating with the general ventricular cavity of the brain by the *foramen of Majendie*, an aperture in the pia mater of the fourth ventricle—this space contains an abundant serous secretion, the *cerebro-spinal fluid;* and the *pia mater*, sending a fold down into the anterior median fissure, not posterior, having medianly in front a fibrous band, the *linea splendens*, and on each side another, the *ligamentum denticulatum*, whose outer border presents twenty-one serrations, the apices of each being attached to the inner surface of the dura mater, serving to support the cord.

Describe the fissures.

They are the *anterior* and the *posterior median*, dividing the cord into two lateral halves, joined by a white and a gray *commissure;* on each side of the anterior fissure is a series of foramina for the exit of the anterior roots of the nerves; this line of openings is called the *antero-lateral groove;* a *postero-lateral groove* runs parallel to the posterior median fissure on each side for the entrance of the posterior roots; a delicate groove between the postero-lateral groove and the posterior median fissure exists, the *posterior intermediate furrow*, most marked in the cervical region.

Name the columns of the cord marked off by these fissures.

One plan is to make three columns for each half—anterior, lateral, and posterior. It is better to disregard the antero-lateral groove, making three columns—antero-lateral, postero-lateral, and posterior median. The *antero-lateral column* includes more than two-thirds of the surface, passing from the anterior median fissure to the postero-lateral groove; the *postero-lateral column* includes the part between the postero-lateral groove and the posterior intermediate furrow; the *posterior median column* is between the posterior intermediate furrow and the posterior median fissure.

What is the ventricle of the cord?

The fetal *central canal*, usually obliterated, runs in the gray commissure the whole length of the cord, enlarged below, and opens into the fourth ventricle above.

The Cranial Nerves.

Describe them.

The cranial nerves number twelve pairs, named in the order of their passage through the cranial foramina; other names are given according to their function or distribution. Each has its *superficial origin*, but also some special center, called the *nucleus:* this is the *deep* or *real origin*.

First, Olfactory$^{\text{I}}$ (Fig. 111), nerves of smell; *superficial origin*, from the olfactory bulb, a lobe of the brain, which is the termination of the olfactory tract, having three roots (p. 232), one from the temporal lobe, one from the frontal, and one from the gyrus fornicatus; twenty non-medullated filaments pass in three groups through the foramina in the cribriform plate to the upper part of the nasal mucous membrane, to the *cells of Schultze*.

Second, Optic$^{\text{II}}$, nerve of sight; *deep origin*, from the optic tracts$^{\text{II}'}$, which arise from the optic thalami, corpora geniculata, and superior pair of the corpora quadrigemina;

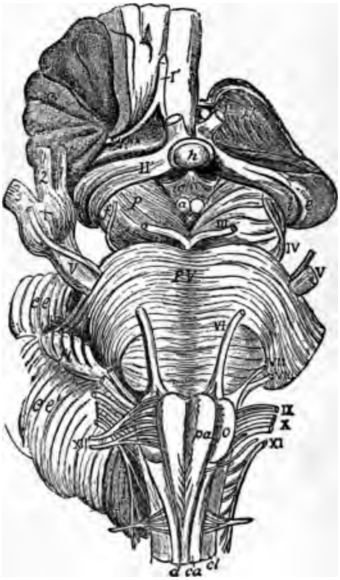


FIG. 111.—The cranial nerves at the base of the brain (Leidy).

is also attached to the crus cerebri and receives fibers from the tuber cinereum and lamina cinerea; in front of the tuber cinereum lies the optic *chiasma* or *commissure*, formed of six sets of fibers, viz. a set crossing from the right side of the brain to the left eye; a second pursuing the same course from the opposite side, *decussating fibers;* a third, anterior, connecting the two retinæ, *interretinal fibers;* a fourth and fifth, lateral, *cerebro-retinal,* connecting the hemisphere of one side with the retina of the eye of the same side; a sixth *intercerebral* set, Gudden's commissure, which connects the internal geniculate bodies and the inferior quadrigeminal tubercles; *distribution*, retina.

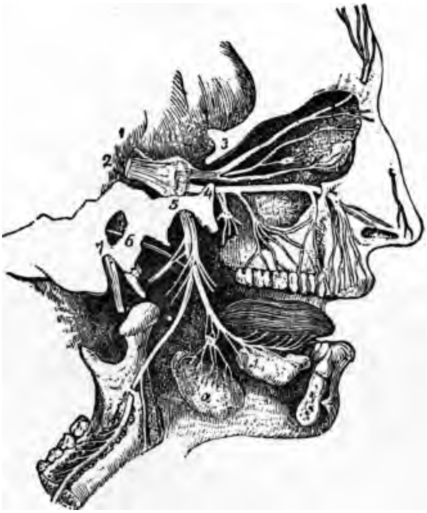


FIG. 112.—The distribution of the three divisions of the fifth nerve (Leidy).

Third$^{\text{iii}}$, Motor oculi; *superficial origin*, inner surface of the crus cerebri; *deep origin*, a nucleus in the floor of the aqueduct of Sylvius; *escapes* in two branches by the sphenoidal fissure; *distribution*, to all eye-muscles, including the iris and ciliary muscle, except the external rectus and superior oblique.

Fourth$^{\text{iv}}$, Trochlear, Patheticus, motor; *superficial origin*, valve of Vieussens; *deep origin*, floor of the aqueduct of Sylvius; *escapes* through the sphenoidal fissure; *distribution*, to the superior oblique of the eye.

Fifth[v], Trigeminus or Trifacial, nerve of general sensation, motion, and perhaps taste; *superficial origin*, by a motor and a sensory root from the side of the pons Varolii; *deep origin*, sensory root from the nucleus in the pons just below the floor of the upper half of the fourth ventricle; the *Gasserian ganglion* formed on this root lies on the apex of the petrous portion of the temporal bone; the motor root arises from a mass of gray cells to the inner side of the nucleus of the sensory root; *escapes*, ophthalmic[3] division (Fig. 112), by the sphenoidal fissure, superior maxillary[4] by the foramen rotundum, inferior maxillary[5] by the foramen ovale.

Ophthalmic division[3] (Fig. 112), purely sensory, supplies the eyeball, ciliary muscle, iris, lacrimal gland, nasal and ocular mucous membrane, skin and muscles of the eyebrow, forehead and nose, ciliary ganglion and dura; its branches are:

Frontal, Lacrimal, Nasal,
Meningeal or (nervus tentorii).

Superior maxillary division[4] (Fig. 112), sensory, is distributed to the temple, cheek, lower eyelid, nose, upper lip and teeth, and, by Meckel's ganglion connected with this nerve, to the palate and pharynx; its branches are:

- *Meningeal*,
- *Orbital* or *temporo-malar*,
- *Superior dental*
  - *Anterior*,
  - *Middle*,
  - *Posterior*.
- *Two spheno-palatine*,
- *Infraorbital*
  - *Palpebral*,
  - *Nasal*,
  - *Labial*.

Inferior maxillary division[5] (Fig. 112), nerve of common sensation and motion; supplies the muscles of mastication, teeth, gums, skin of the temple and of the external ear, lower part of the face and lower lip, the tongue, otic and submaxillary ganglia; its branches are:

- *Meningeal (nervus spinosus)*,
- *Masseteric*,
- *Three deep temporal*,
- *Buccal (sensory)*,
- *Two pterygoids*,
- *Auriculo-temporal*,
- *Lingual*,
- *Inferior dental*
  - *Mylo-hyoid*,
  - *Dental*,
  - *Incisor*,
  - *Mental*.

Describe the cranial and facial ganglia.

The *Gasserian ganglion* is convex anteriorly, rests between two layers of the dura in the *cavum Meckelii* on the apex of the petrous portion ; under it are the motor root and the large superficial petrosal nerve; it gives off meningeal branches and three divisions of the fifth nerve, the inferior one joining the motor root.

The *ciliary* or *ophthalmic ganglion* is in the orbit.

The *spheno-palatine ganglion* (Meckel's) is in the spheno-maxillary fossa.

The *otic ganglion* (Arnold's) is on the inner side of the inferior maxillary nerve below the foramen ovale.

Ganglia are occasionally found on the middle meningeal, lingual, temporal, and pharyngeal arteries, receiving the name of their location or discoverer, as Bidder or Cloquet.

The *ganglion of Bochdalek* is situated in the external wall of the antrum, at the junction of the middle and anterior superior dental nerves from the infraorbital; the *ganglion of Valentin* is at the junction of the middle and posterior superior dental.

The *submaxillary ganglion* lies above the deep portion of the submaxillary gland.

Describe the ciliary ganglion.

Situated in the orbit between the optic nerve and the external rectus muscle ; its roots are : *sensory*, from the nasal branch of the ophthalmic (fifth pair) ; *motor*, branch of the third nerve to the inferior oblique muscle ; *sympathetic*, cavernous plexus ; its *branches* are : *short ciliary* in two bundles of twelve to twenty twigs to the ciliary muscle, iris, and cornea.

Describe the spheno-palatine ganglion.

Deeply placed in the spheno-maxillary fossa; its roots are *sensory*, from the superior maxillary; *motor*, facial, through the large superficial petrosal; *sympathetic*, from the carotid plexus, through the large deep petrosal; its branches are:

Ascending,
Anterior palatine,
Posterior palatine,
External palatine,
Pharyngeal, or *Pterygo-palatine,*
Superior nasal (*anterior*),
Superior nasal (*posterior*),
Naso-palatine.

Describe the otic ganglion.

It lies beneath the foramen ovale, internal to the inferior maxillary nerve, external to the Eustachian tube and in front of the middle meningeal artery. Its *motor* and *sensory roots* come from the nerve to the internal pterygoid, *sympathetic* from the middle meningeal plexus; it connects with the facial and glosso-pharyngeal, and gives a *sphenoidal twig* to the Vidian. *Branches* pass to the auriculo-temporal, chorda tympani, and buccal nerves, to the internal pterygoid, tensor palati, and tensor tympani muscles.

Describe the submaxillary ganglion.

Situated above the deep portion of the submaxillary gland; its roots are: *sensory*, from the lingual nerve; *motor*, facial, through the chorda tympani; *sympathetic*, from the facial plexus; its *branches* go to the mucous membrane of the mouth, to the submaxillary gland, and to its duct.

Describe the petrosal nerves.

The *great petrosal* (large superficial petrosal) may be described as a branch of the spheno-palatine ganglion passing through the Vidian canal, distributing twigs to the mucous membrane of the back part of the nose, septum, and Eustachian tube, passing longitudinally through the foramen lacerum medium, where it divides into the *large superficial petrosal*, which enters the hiatus Fallopii, receives a twig from Jacobson's nerve, and terminates in the geniculate ganglion of the facial nerve, and the *carotid* (*large deep petrosal*) joining the carotid plexus.

Small superficial petrosal connects the geniculate ganglion of the seventh nerve and the tympanic plexus with the otic ganglion.

External petrosal (external superficial petrosal) passes from the geniculate ganglion of the seventh nerve to the middle meningeal plexus.

More correctly, the large superficial petrosal and the large deep petrosal may be said to *form* the Vidian nerve, which runs forward through the same named canal to join the spheno-palatine ganglion, supplying it with motor and sympathetic fibers. According to this description, the twigs said to be given off by the Vidian nerve to the nasal mucous membrane must be considered branches of the *ganglion* running back in the same sheath.

Sixth, Abducens$^{\text{vi}}$ (Fig. 111), motor; *superficial origin*, between the anterior pyramid and the pons Varolii; *deep origin*, from the nucleus in the fasciculus teres on the upper half of the floor of the fourth ventricle; *escapes*, by the sphenoidal fissure; *distribution*, external rectus muscle.

Seventh, Facial$^{\text{vii}}$ (Fig. 111), or *portio dura of the seventh nerve*, the motor nerve of all muscles of expression, of the platysma, buccinator, the muscles of the external ear, posterior belly of the digastric, stylo-hyoid, stapedius, through the chorda tympani the lingualis, according to some through the great superficial petrosal, the levator palati, and the azygos uvulæ muscles; *superficial origin*, medulla, from the groove between the olivary and restiform bodies; *deep origin*, from the nucleus in the formatio reticularis of the pons below the floor of the fourth ventricle arching over the nucleus of the sixth nerve; *escapes* by the internal auditory meatus to the aquæductus Fallopii, and thence by the stylo-mastoid foramen; *distribution*, to muscles already mentioned; its branches are:

Tympanic (to stapedius),
Chorda tympani,
Posterior auricular,

Digastric,
Stylo-hyoid,

- *Temporo-facial*
  - *Temporal*,
  - *Malar*,
  - *Infraorbital*,
- *Cervico-facial*
  - *Buccal*,
  - *Supramaxillary*,
  - *Inframaxillary*.

The communications of the facial are:

With the auditory nerve: Meckel's ganglion by the large superficial petrosal; otic ganglion by the small superficial petrosal; sympathetic on the middle meningeal by the external petrosal nerve; with the pneumogastric, glosso-pharyngeal, carotid plexus, auricularis magnus, auriculo-temporal, and with the three divisions of the fifth nerve.

Eighth, Auditory$^{\text{viii}}$, *portio mollis*, nerve of hearing; it begins by two roots, the *mesial* (anterior) emerges from the groove between the olivary and restiform bodies at the lower border of the pons; *deep origin*, *dorsal auditory nucleus* under the trigonum acustici; the *lateral root* (posterior) passes around the outer side of the restiform body and appears to be continuous with the striæ medullares; *escapes* by the internal auditory meatus; *distribution*, to the internal ear; its branches are:

Vestibular, to the vestibule,
Cochlear, to the cochlea (see p. 374).

Ninth, Glosso-pharyngeal$^{\text{viii a}}$ (Fig. 111), nerve of common sensation and taste; *superficial origin*, medulla in the groove just behind the olivary body; *deep origin*, gray nucleus at the inferior fovea in the lower half of the floor of the fourth ventricle; *escapes* at the central part of the jugular foramen, after which it presents two gangliform enlargements, the *jugular* and *petrosal ganglia; distribution*, to the muscles of the pharynx, mucous membrane of the pharynx, fauces, tonsil, tongue, and the middle ear; its branches are:

Tympanic (Jacobson's),
Carotid,
Pharyngeal,
Muscular,
Tonsillar,
Lingual.

Tenth, Pneumogastric$^{\text{x}}$ (Fig. 111), *nervus vagus*, has an extensive distribution both motor and sensory; *superficial origin*, from the lateral tract of the medulla oblongata behind the olivary body and below the glosso-pharyngeal; *deep origin*, ala cinerea in the lower part of the floor of the fourth ventricle —the motor filaments probably come from the spinal accessory; *escapes* by the jugular foramen, presenting a gangliform enlargement, *ganglion of the root*, and lower another, *ganglion of the trunk; distribution*, to the organs of the voice and respiration, the pharynx, esophagus, stomach, and heart; the branches are:

Meningeal,
Auricular,
Pharyngeal,
Superior laryngeal,
Recurrent laryngeal,
Cervical cardiac,
Thoracic cardiac,
Anterior pulmonary,
Posterior pulmonary,
Esophageal,
Gastric,
Abdominal plexuses.

Eleventh, Spinal accessory$^{\text{xi}}$, is a motor nerve, spinal part to two muscles, accessory part to the vagus; *superficial origin*, lateral tracts of the medulla oblongata below the roots of the vagus, and from the same part of the spinal cord to the fifth or sixth cervical vertebra; *deep origin*, gray matter below the nucleus of the vagus and intermedio-lateral tract of the cord; it sends filaments to the ganglion of the root of the vagus, to the pharyngeal and superior laryngeal branches of the same nerve; *escapes* by the jugular foramen, the spinal portion first entering the skull through the foramen magnum; *distribution*, to the sterno-mastoid and trapezius, muscles of the larynx, of the soft palate, except the tensor palati, constrictors of the pharynx, inhibitory fibers to the heart.

Twelfth, Hypoglossal^{xii} (Fig. 111), motor nerve of the tongue; *superficial origin*, groove between the pyramid and olivary body in the line of the anterior nerve-roots; *deep origin*, trigonum hypoglossi on the floor of the fourth ventricle; *escapes* by the anterior condyloid foramen; *branches* are *meningeal*, *vascular*, *muscular;* latter to the intrinsic fibers of the tongue, lingualis, hyo-, stylo-, and genio-hyoglossus; it communicates with the tenth, lingual, three upper cervical, and sympathetic nerves; the *descendens cervicalis* from the first and second cervicals runs in the sheath of the hypoglossal; the *communicans cervicalis*, rising from the second and third cervicals meets the descendens in a loop, *ansa cervicalis;* these three cervicals supply the genio-hyoid and the infrahyoid group of muscles.

The Spinal Nerves.

How many pairs of spinal nerves are there?

Eight cervical, twelve thoracic, five lumbar, five sacral, and one coccygeal—thirty-one in all.

Describe their origin.

Each nerve arises by an anterior *motor* root, emerging from the antero-lateral groove, and a posterior *sensory* entering the postero-lateral groove; these perforate the dura, the posterior develops a ganglion, and they unite to pass through the intervertebral foramina—except the first cervical, which emerges above the atlas—after which they break up into *anterior* and *posterior divisions*, the latter, the smaller, supplying the spine, dorsal muscles, and integument, while the anterior larger divisions form plexuses whence the remainder of the trunk and the limbs receive their nerve-supply.

Describe the cervical plexus with its branches.

It is formed by the anterior divisions of the four upper cervical nerves lying upon the levator scapulæ and scalenus medius muscles; its branches are the *superficial* and *deep:*

Ascending	*Superficialis colli,* *Auricularis magnus,* *Occipitalis minor.*	*Internal*	*Communicating,* *Muscular,* *Communicans cervicalis,* *Descendens cervicalis,* *Phrenic.*
Descending	*Suprasternal,* *Supraclavicular,* *Supra-acromial.*		
		External	*Communicating,* *Muscular.*

Describe the phrenic nerve.

It *arises* chiefly from the fourth cervical nerve with branches from the third and fifth, runs obliquely over the scalenus anticus muscle, passes between the subclavian artery and vein, enters the chest anterior to the internal mammary artery, to be *distributed* to the pericardium, pleura, and under surface of the diaphragm and phrenic plexus; Luschka describes twigs to the peritoneum, inferior vena cava, and right auricle of the heart; it is joined by filaments from the sympathetic, from the nerve to the subclavius muscle, and one from the union of the descendens cervicalis with the spinal nerves.

Describe the brachial plexus with its branches.

It is formed by the union of the anterior trunks of the four lower cervical and first thoracic nerves; four special names are used—anterior *nerves* form *trunks*, trunks form *divisions* or branches and these form *cords*. The fifth and sixth cervical nerves join and form an *upper trunk;* the eighth cervical and first thoracic unite and form a *lower trunk;* the seventh remains single and forms a *middle trunk;* each trunk divides into an *anterior* and a *posterior division;* the anterior divisions of the upper and middle trunks unite and form the *outer cord;* the anterior division of the lower trunk forms by itself the *inner cord*, and the posterior divisions of all three form the *posterior cord;* sometimes the posterior division of the lower trunk does not meet the other two, but runs lower down into the musculo-spiral nerve. From the *outer cord* arise the external anterior thoracic nerve, nerve to the coraco-brachialis, musculo-cutaneous, and the outer head of the median; from the *inner cord* arise the internal anterior thoracic, lesser internal cutaneous, internal cutaneous, ulnar, and inner head of the median; from the *pos-*

terior cord arise three subscapular nerves, the circumflex, and the musculo-spiral. *Branches of communication* are with the fourth cervical, second thoracic, phrenic, and sympathetic system; *branches of distribution* are (I) to the muscles of the trunk, (II) of the shoulder girdle, and (III) of the upper extremity.

(I) *Muscular* to the longus colli and three scaleni; lower part of scalenus anticus and medius; whole of scalenus posticus.

(II) 1. *Twig to* the rhomboidei *from* the fifth cervical.

2. *Posterior* or *long thoracic*, *from* the fifth, sixth, and seventh nerves, *to* the serratus magnus muscle.

3. *Suprascapular*, *from* the upper trunk; *to* the supra and infraspinatus muscles and shoulder-joint.

4. *Nerve to* the subclavius *from* the upper trunk, mainly from the fifth.

5. *External and internal anterior thoracic*, the former *from* the outer cord, the latter *from* the inner cord; both *to* the pectoralis major, the internal to the pectoralis minor.

6. *Three subscapular*, the upper *from* the communicating branch from the outer to the posterior cord, the other two from the posterior cord; *to* the subscapularis, teres major, and latissimus dorsi muscles.

7. *Circumflex*, *from* the posterior cord with the musculo-spiral; *to* the deltoid and teres minor, the shoulder-joint, and skin of the lower deltoid region.

8. *Nerve from* the outer cord *to* the *coraco-brachialis.*

(III) There are five anterior *arm-nerves*, one posterior; *musculo-cutaneous*, *from* the outer cord pierces the coraco-brachialis; *to* biceps, brachialis anticus, and elbow-joint, and skin of the outer surface of the forearm; *internal cutaneous*, *from* the inner cord *to* the skin over the biceps and that of the inner half of the forearm in front and behind; *lesser internal cutaneous* (nerve of Wrisberg), *from* the inner cord alone, or a branch from this joined with the intercosto-humeral, the lateral cutaneous branch of the second intercostal nerve; or, again, the intercosto-humeral may entirely replace it; *to* the skin of the inner side of the arm; *median*, *from* the outer and inner cords by two roots that embrace the axillary artery, uniting in front or to its outer side, first lying external to the brachial artery, then crossing to its inner side, passing between the two heads of the pronator teres muscle to run between the deep and superficial flexors of the fingers to near the wrist, where it becomes superficial;

its branches are *articular to* the elbow, wrist, metacarpus, and fingers; *muscular, to* all anterior superficial forearm-muscles except the flexor carpi ulnaris; *anterior interosseous, to* the deep forearm-muscles except the inner half of the flexor profundus digitorum; *palmar cutaneous*, piercing the fascia above the wrist *to* the skin of the thenar eminence; branches *to* the abductor, opponens, and outer head of the flexor brevis pollicis; *five digitals*, supplying both sides of the thumb, index, middle, and radial side of the ring fingers.

Ulnar, from the inner cord runs behind the inner epicondyle, passing into the forearm between the heads of the flexor carpi ulnaris to run some distance from the ulnar artery at the upper third, but close to it for the rest of its extent; it supplies both sides of the little and ulnar side of the ring finger and skin internally of the forearm and hand; its branches are *articular for* the elbow, wrist, metacarpus, and hand; *muscular, to* the flexor carpi ulnaris, inner half of the flexor profundus digitorum, the little finger muscles, the interossei and inner two lumbricals, palmaris brevis, adductores pollicis, and inner head of the flexor brevis pollicis.

Names of branches in the forearm are: *Articular, muscular, cutaneous, dorsal cutaneous;* in the hand, *superficial* and *deep palmar.*

Musculo-spiral, from the posterior cord, runs in the spiral groove with the superior profunda vessels to divide in front of the external condyle of the humerus into the *radial* and *posterior interosseous;* its branches are:

Radial,
Posterior interosseous,
Muscular,
Cutaneous,
Articular (elbow and wrist).

Radial, to the skin of the ball of the thumb, to back of the thumb as far as the nail, back of first phalanx of the index finger, and back of the radial half of the first phalanx of the middle finger; *posterior interosseous*, supplying the wrist-joint and all muscles on the back of the forearm except the anconeus, supinator longus, and extensor carpi radialis longior; *muscular, to* the triceps, anconeus, supinator longus, extensor carpi radialis longior, and brachialis anticus; *cutaneous, to* the skin of the outer and back part of the arm and forearm.

The Thoracic Nerves.

Describe them.

Twelve in number on each side, the first escapes between the first and second thoracic vertebræ, the last between the last thoracic and first lumbar; they divide into an *anterior* and a *posterior* division, the latter supplying the spine, extensor muscles of the back, and the dorsal integument; the former (anterior) are the *intercostal nerves*, the twelfth being called *subcostal*, each connected by one or two filaments with the adjacent sympathetic ganglion: the anterior division of the *first* nerve aids in the formation of the brachial plexus; its intercostal branch is small and gives off no lateral cutaneous branch; the lateral branch of the *second* nerve is the intercosto-humeral; the nerves give off *lateral* and *anterior cutaneous branches* supplying the skin of the front and sides of the thorax and abdomen, while they give *muscular branches* to the intercostal and abdominal muscles.

Describe the lumbar nerves.

The posterior branches resemble in origin and arrangement those of the thoracic region, while their anterior branches form the lumbar and part of the sacral plexuses; there are five pairs.

Describe the lumbar plexus and branches.

It is formed by loops of communication between the anterior divisions of the four upper lumbar nerves in the substance of the psoas muscle, thus the first lumbar is joined by a branch from the last thoracic, *dorso-lumbar*, and gives off the *ilio-hypogastric* and *ilio-inguinal* and a branch to the *genito-crural;* the second goes to the *genito-crural* and *external cutaneous* and gives a descending branch to the anterior crural and obturator; the third gives off three branches, one to the *external cutaneous*, a large one to the *anterior crural*, and one to the *obturator;* the fourth has three branches, to the anterior crural, to the obturator, and one to join the fifth, forming the *lumbo-sacral cord;* the fourth is called the *nervus furcalis*, splitting like a fork for the two plexuses; the accessory obturator when present comes from the third and fourth nerves.

Branches of the plexus are: 1. Of *communication* with the twelfth thoracic, fifth lumbar, and sympathetic. 2. Of *distri-*

bution, *short set* to the quadratus lumborum, to the psoas magnus or parvus; *long set* to the abdomen and to the thigh, viz. the *ilio-hypogastric*, *ilio-inguinal*, *genital* part of the *genito-crural* to the abdomen; the *anterior crural*, *external cutaneous*, *crural* part of the *genito-crural* and *obturator* to the thigh.

Ilio-hypogastric supplies the skin of the gluteal region, skin and two muscles of the hypogastrium, the internal oblique and transversalis; *ilio-inguinal*, to the internal oblique and transversalis muscles and skin of the scrotum (labium in the female), and the upper inner part of the thigh; *external cutaneous*, to the skin of the antero-external and posterior surfaces of the thigh; *genito-crural*, to the cremaster muscle and skin of the front of the upper part of the thigh; *obturator*, to the obturator externus and adductor muscles, hip- and knee-joints, also sometimes to the skin of the thigh and leg.

The *accessory obturator* is usually lacking; when present it comes from the third and fourth lumbar nerves, crosses the horizontal ramus of the pubes, and divides into three branches: one to the hip-joint, one to the pectineus, and one to join the obturator nerve.

Anterior crural, from the third and fourth, with a communicating branch from the second lumbar nerve. It descends beneath Poupart's ligament external to the femoral artery between the psoas and iliacus muscles, and divides into an anterior and a posterior division: its branches are, within the pelvis,

Muscular to *iliacus*, and to the walls of the *femoral artery;* external to the pelvis,

Anterior division.	*Middle cutaneous,* *Internal cutaneous,* *Muscular.*	Posterior division.	*Long saphenous,* *Articular,* *Muscular.*

It supplies all the anterior thigh-muscles, except the tensor fasciæ femoris, and the skin of the front and inner side of the thigh, leg, and foot.

The muscular branches of the anterior division supply the pectineus and sartorius; the muscular branches of the posterior division supply the quadriceps femoris; the nerve to the rectus sends a filament to the hip-joint, the nerves to the vasti send filaments to the knee-joint.

Describe the sacral plexus.

It is formed by the lumbo-sacral cord (the anterior division of the fifth lumbar nerve with a branch of the fourth), and anterior divisions of the three upper sacral nerves and part of that of the fourth: it rests upon the anterior surface of the pyriformis muscle, giving off the

Superior gluteal, *from* the lumbo-sacral cord, passing out through the greater sacro-sciatic foramen, *to* the gluteus medius and minimus and tensor fasciæ femoris muscles; the *inferior gluteal nerve* supplies the gluteus maximus.

Muscular branches to the pyriformis, obturator internus and superior gemellus, to quadratus femoris and inferior gemellus.

Pudic passes out of the pelvis by the greater sacro-sciatic foramen, to re-enter it by the lesser sacro-sciatic foramen; its branches are:

Inferior hemorrhoidal, *Perineal*, *Dorsal of penis.*

Muscular, *to* the transversus perinei, accelerator urinæ, erector penis, compressor urethræ, levator ani, and external sphincter: the preceding branches supply analogous muscles and parts in the female.

Small sciatic escapes by the greater sacro-sciatic foramen, *to* the skin of the scrotum, lower part of the buttock, back of the leg and thigh; its branches are the *gluteal cutaneous*, *femoral cutaneous*, and *inferior pudendal;* no muscular branches.

Great sciatic is a continuation of the main part of the sacral plexus, forming the largest nerve in the body. Escaping by the greater sacro-sciatic foramen below the pyriformis muscle, it lies in a groove between the great trochanter and the tuber ischii, covered by the gluteus maximus, resting on the obturator internus, gemelli, and quadratus femoris: its branches are *articular* to the hip, *muscular* to the biceps, semitendinosus, semimembranosus, and adductor magnus, and it divides into the *internal* and the *external popliteal nerves.*

Name the branches of the internal popliteal nerve.

Articular to the knee, three in number.

Muscular to the gastrocnemius, plantaris, soleus, and popliteus.

External or *short saphenous* is formed by the junction of a cutaneous branch, *communicans tibialis* or *poplitei*, and another cutaneous branch of the external popliteal, the *communicans fibularis* or *peronei.*

Describe the posterior tibial nerve.

It is a continuation of the former, runs down the middle of the back of the leg beneath the calf-muscles to divide between the inner malleolus and point of the heel into the internal and external plantar; its branches are:

Muscular, to the tibialis posticus, flexor longus digitorum, flexor longus hallucis, and the soleus muscles; *articular*, to the ankle-joint.

Plantar cutaneous, to the skin of the heel and inner side of the sole of the foot.

Fibular branch, to the vessels, periosteum, and medullary canal of the fibula.

Internal plantar, supplying the skin of the sole, tarsal and metatarsal joints, one or two inner lumbricals, abductor hallucis, flexor brevis hallucis, and digitorum, four *digital* branches to both sides of the first, second, and third toes, and inner half of the fourth.

External plantar, smaller than the preceding, supplying the flexor accessorius, abductor, and flexor brevis minimi digiti, all the interossei, two or three outer lumbricals, adductor obliquus, and transversus hallucis, and the skin of the little toe and the adjoining side of the fourth toe.

Describe the external popliteal nerve.

It descends obliquely along the outer side of the popliteal space close to the tendon of the biceps, giving off

Three *articular branches* to the knee; a *cutaneous branch* to the skin of the postero-external surface of the leg, and a branch, the *communicans peronei*, forming part of the external saphenous nerve: it divides into the

Anterior tibial, about one inch below the head of the fibula, giving *muscular branches* to the tibialis anticus, extensor longus digitorum, peroneus tertius, extensor longus hallucis, and extensor brevis digitorum; *articular* to the tarsal and metatarsal joints, and *cutaneous* to the skin of the adjacent sides of the great and second toes.

Musculo-cutaneous, giving off *muscular branches* to the peroneus longus and brevis, and *cutaneous* to the skin of the lower part of the leg, and dorsum of the foot and toes, except the outer side of the little and adjoining sides of the great and second toes.

Describe the sacral and coccygeal nerves.

They are six in number, their long roots forming the *cauda equina* in the spinal canal; each divides into an *anterior* and a *posterior division*, the latter escaping by the posterior sacral foramina, except the fifth, which emerges between the sacrum and coccyx, and supplies the multifidus spinæ muscle and the skin of the posterior gluteal region; a branch goes from the third and fourth nerves to the bladder; the two lower nerves join with the coccygeal, forming loops, which supply the skin over the coccygeal region and the coccygeus, levator ani, and sphincter ani muscles.

The Sympathetic System.

What is the sympathetic nerve or system?

It consists of (1) a series of ganglia with intervening longitudinal bands, forming two cords, one on each side of the spinal column connected above according to some by the *ganglion of Ribes*, and below by the *ganglion impar* or *coccygeal ganglion*, in front of the coccyx; (2) three prevertebral plexuses, one each for the thorax, abdomen, and pelvis; (3) small ganglia; (4) nerve-fibers of *communication* with the cerebro-spinal nerves, of *distribution* supplying the viscera and vessels.

Describe the cervical ganglia.

There are three on either side, viz. the

Superior cervical ganglion. It is placed opposite the second and third cervical vertebræ behind the carotid sheath, and gives off a

Superior branch to the internal carotid artery, forming by its division the cavernous plexus and carotid plexus (with their subdivisions);

Descending branch, connecting the superior with the middle ganglion;

External branches to the cranial and spinal nerves, and *anterior branches* forming plexuses on the external carotid and its branches;

Pharyngeal, forming with branches from the spinal accessory, pneumogastric, glosso-pharyngeal, and external laryngeal nerves, the *pharyngeal plexus; laryngeal*, uniting with the superior laryngeal nerve and its branches;

Superior cardiac, connected with other branches of the sympathetic, and with some of the pneumogastric, passes to the back of the aorta, the right joining the *deep*, and the left (usually) the *superficial* cardiac plexus.

Middle cervical ganglion is placed opposite the sixth cervical vertebra; and by its

Superior and *inferior branches* it communicates respectively with the superior and the inferior cervical ganglia; the *external* filaments join the fifth and sixth cervical nerves, the internal are the *thyroid* to the inferior thyroid artery and thyroid gland, and the *middle* or *great cardiac nerve*, communicating with other sympathetic branches and the recurrent laryngeal, to terminate in the deep cardiac plexus.

Inferior cervical ganglion is placed between the base of the transverse process of the seventh cervical vertebra and neck of the first rib on the inner side of the superior intercostal artery; its *superior* and *inferior branches* connect it respectively with the middle cervical and the first thoracic ganglion; the *external* branches join the spinal nerves, others form a plexus on the vertebral artery; its chief branch is the

Inferior cardiac nerve, communicating with the recurrent laryngeal and middle cardiac nerves, terminating in the deep cardiac plexus.

What is the carotid plexus?

It is a plexus situated on the outer side of the internal carotid artery communicating with the Gasserian and spheno-palatine ganglia, the sixth nerve, and the tympanic branch of the glosso-pharyngeal; it supplies the carotid artery and dura mater.

What is the cavernous plexus?

It is one situated below and internal to that part of the internal carotid artery running alongside of the sella turcica, in the cavernous sinus; it communicates with the third, fourth, fifth, and sixth nerves, and ophthalmic ganglion, and supplying the carotid, it, with the carotid plexus, forms plexuses embracing the cerebral and ophthalmic arteries.

What are the other ganglia of the sympathetic system?

Usually eleven thoracic, four lumbar, four or five sacral, ganglion impar, and numerous ganglia connected with the various viscera, whence plexuses are formed named from their locality or the organ involved.

Describe the sacral an
They are six in nu
cauda equina in the sp
rior and a *posterior*
posterior sacral foram
between the sacrum a
spinæ muscle and the
branch goes from the
the two lower nerves
which supply the skin
geus, levator ani, and

The

What is the sympath
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column connected ab
Ribes, and below by
in front of the coccy
each for the thorax
(4) nerve-fibers of
nerves, of *distribu*

Describe the cervic
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and third cervical
gives off a
Superior branch
its division the
their subdivisions
Descending bran
ganglion;
External branc
terior branches for
branches;
Pharyngeal, for
sory, pneumogast
geal nerves, the
the superior lary
Superior cardia

of the trachea, and above that of the pulmonary artery, behind the aortic arch, and is formed by all the sympathetic cardiac nerves (except the left superior) and cardiac branches of the recurrent laryngeal and pneumogastric (except the left superior cardiac and the left inferior cardiac of the pneumogastric).

Superficial cardiac lies beneath the aortic arch in front of the right pulmonary artery, and is formed by the left superior cardiac of the sympathetic, left inferior cardiac of the pneumogastric, and branches from the deep cardiac plexus.

Coronary, the *posterior*, chiefly from the deep, the *anterior* from the superficial cardiac plexus.

Aortic, on the sides and front of the aorta between the origins of the superior and inferior mesenteric arteries.

Hypogastric, lying in front of the sacrum, between the common iliac arteries, supplies the pelvic viscera, and is formed by filaments from the aortic plexus, and from the lumbar and first two sacral ganglia, contains no ganglia, and divides into two lateral portions, forming the inferior hypogastric or pelvic plexuses.

Pelvic plexuses, two in number, lie upon each side of the rectum and bladder (rectum, vagina, and bladder in females), and each is formed by a continuation of the hypogastric plexus and branches from the second, third, and fourth sacral nerves, and a few filaments from the sacral ganglia; the branches accompany those of the internal iliac artery, and are distributed to all the pelvic viscera; their branches are:

Inferior hemorrhoidal plexus,	
Vesical plexus,	*Vaginal plexus,*
Prostatic plexus { *Small and large cavernous nerves* to penis.	*Uterine nerves.*

VISCERAL ANATOMY.

The Digestive Organs.

What is a viscus?

Any of the internal organs with their appendages, contained within the four cavities, cranial, thoracic, abdominal, or pelvic.

Of what does the digestive apparatus consist?

Of the alimentary canal, a musculo-membranous tube, lined

What are the branches of the thoracic portion?

Communicating, with one another and the thoracic spinal nerves, filaments to the aorta and its divisions and to the posterior pulmonary plexus, and

The *great splanchnic nerve*, formed by the internal branches from the thoracic ganglia between the fifth or sixth and ninth or tenth inclusive; it perforates the crus of the diaphragm to terminate in the semilunar ganglion, sending branches to the renal plexus and suprarenal capsule.

The *small splanchnic*, springing from the ninth and tenth, or from the tenth and eleventh ganglia and cord communicating with the great splanchnic, pierces the diaphragm with the preceding, to join the celiac plexus.

Smallest, or *renal splanchnic*, arises from the last ganglion, occasionally communicates with the preceding, pierces the diaphragm, and terminates in the renal and lower part of the celiac plexus.

Describe the solar plexus.

It supplies all the abdominal viscera, consisting of a network of nerves and ganglia lying in front of the aorta and crura of the diaphragm, surrounding the celiac axis and root of the superior mesenteric artery, extending below to the pancreas, and laterally to the suprarenal capsules. The great splanchnic and part of the small splanchnic nerves of both sides and the termination of the right pneumogastric form this plexus, in conjunction with the two semilunar ganglia, these latter being large, irregular gangliform masses, composed of smaller ganglia separated by interspaces, placed by the side of the celiac axis and superior mesenteric artery, close to the suprarenal capsules, that on the right lying beneath the vena cava. From this are derived the following plexuses accompanying the same named arteries to the various organs:

- *Phrenic*, or *diaphragmatic*,
- *Celiac*
  - *Gastric*,
  - *Hepatic*,
  - *Splenic*,
- *Aortic*,
- *Suprarenal*,
- *Renal*,
- *Superior mesenteric*,
- *Spermatic*,
- *Inferior mesenteric*.

Name some of the more important plexuses.

Tympanic (see page 370).

Great, or *deep cardiac* is placed in front of the bifurcation of the trachea, and above that of the pulmonary artery, behind the aortic arch, and is formed by all the sympathetic cardiac nerves (except the left superior) and cardiac branches of the recurrent laryngeal and pneumogastric (except the left superior cardiac and the left inferior cardiac of the pneumogastric).

Superficial cardiac lies beneath the aortic arch in front of the right pulmonary artery, and is formed by the left superior cardiac of the sympathetic, left inferior cardiac of the pneumogastric, and branches from the deep cardiac plexus.

Coronary, the *posterior*, chiefly from the deep, the *anterior* from the superficial cardiac plexus.

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Hypogastric, lying in front of the sacrum, between the common iliac arteries, supplies the pelvic viscera, and is formed by filaments from the aortic plexus, and from the lumbar and first two sacral ganglia, contains no ganglia, and divides into two lateral portions, forming the inferior hypogastric or pelvic plexuses.

Pelvic plexuses, two in number, lie upon each side of the rectum and bladder (rectum, vagina, and bladder in females), and each is formed by a continuation of the hypogastric plexus and branches from the second, third, and fourth sacral nerves, and a few filaments from the sacral ganglia; the branches accompany those of the internal iliac artery, and are distributed to all the pelvic viscera; their branches are:

Inferior hemorrhoidal plexus,
Vesical plexus,
Prostatic plexus { *Small and large cavernous nerves* to penis.
Vaginal plexus,
Uterine nerves.

VISCERAL ANATOMY.

The Digestive Organs.

What is a viscus?

Any of the internal organs with their appendages, contained within the four cavities, cranial, thoracic, abdominal, or pelvic.

Of what does the digestive apparatus consist?

Of the alimentary canal, a musculo-membranous tube, lined with mucous membrane, about thirty feet long, extending from the mouth to the anus, and certain accessory organs.

Name the subdivisions of the alimentary canal.

Mouth, pharynx, esophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine (cecum, colon, sigmoid flexure, rectum).

What are the accessory organs?

The teeth, salivary glands (parotid, submaxillary, sublingual), liver, pancreas, and spleen.

The Teeth.

What is their function?

To reduce the food to fragments, thus enabling the digestive fluids to act to the best advantage. There are two classes:

Temporary, or *milk teeth*, ten in each jaw, viz. four incisors, two canines, and four molars;

Permanent teeth, sixteen in each jaw, viz. four incisors, two canines, four bicuspids or premolars, and six molars.

The surface of a tooth turned toward the lips or cheeks is called *labial*, or *buccal;* toward the tongue is *lingual;* toward the mesial line is *proximal;* and away from it is *distal.*

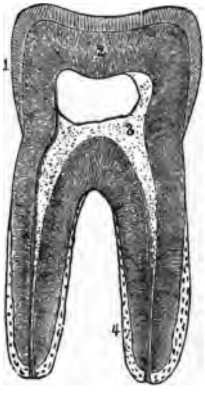


FIG. 113.—Vertical section of a molar tooth. (Leidy.)

Of what parts does every tooth consist?

Of a *crown*, or *body* (Fig. 113), that part projecting above the gum.

Neck, the constricted portion between the crown and the fang.

Fang[4], or *root*, that part occupying the alveolus, held there by the *dental periosteum* lining the socket and investing the fang; teeth are steadied by the *gums*, composed of dense fibrous tissue covered with mucous membrane.

Pulp-cavity[3], an interior cavity filled with the tooth-pulp, a vascular connective tissue with numerous nerves, both arteries and nerves reaching the pulp by a canal opening at the apex of the fang.

Describe the characteristics of each of the four varieties of teeth.

Incisor, or *cutting teeth*. The crown is wedge-shaped, convex in front, bevelled and slightly concave behind; the fang is single, long, conical, and transversely flattened; the lingual surface shows a *basal ridge*, or *cingulum*.

Canines. Crown is large, conical, convex in front, rises above the level of the other teeth; fang long, conical, compressed laterally; upper pair are called in common parlance eye-teeth," the lower "stomach-teeth."

Bicuspids. Crown has two projecting cusps, fang generally is single, laterally grooved with a bifid apex; they are also called *premolars;* the upper are larger than the lower.

Molars (grinders). Crown nearly cubical, with four cusps in the upper, and five in the lower molars; fangs, usually three for the first two upper, and two for the first two lower molars; the third molar is called the "wisdom tooth" (*dens sapientiæ*), from its late appearance, and usually has but one fang with grooves indicating a tendency to the formation of three fangs in the upper, and two in the lower jaw.

The *second temporary molar* is the largest milk tooth, and is succeeded by the second permanent bicuspid.

Describe the structure of a tooth.

Each is formed chiefly of

Dentine, or *ivory*[2], composed of minute, wavy, branching tubes, called *dentinal tubes*, embedded in a hard, homogeneous tissue, the *intertubular substance*. The tubules are about $\frac{1}{4500}$ of an inch in diameter, dividing dichotomously, giving the wavy appearance of the cut surface, and open into the pulp-cavity. Chemically dentine consists of twenty-eight parts of animal and seventy-two of earthy matter.

Enamel[1] forms a thin crust over the crown, is the densest of all animal tissues, containing only 3.5 per cent. of animal matter, and is composed of minute parallel hexagonal rods, or *enamel columns*, about $\frac{1}{5500}$ of an inch in diameter, pursuing a wavy course.

Cement, or *crusta petrosa*[4], is a layer of true bone commencing at the neck, covering the fang, and becoming thicker ward its apex.

Pulp, filling the pulp-cavity[3], consisting of lar connective tissue, with numerous nerves and cells, the latter being of two kinds, columnar, called *odontoblasts*—arranged in a layer lining the pulp-cavity—some stellate and fusiform cells wedged in between these permeate the pulp, having fine processes, prolonged into the dentinal tubules; certain filaments in the tubules are *Tomes' fibers.*

Whence do teeth obtain their blood- and nerve-supply?

From the alveolar and infraorbital branches of the internal maxillary, and from the inferior dental artery; the nerves come from the anterior and posterior dental branches of the superior maxillary, and from the inferior maxillary division of the fifth nerve.

When do the temporary teeth appear?

The time is variable, but, according to the latest authority, they erupt as follows, expressed in *months:*

	Molar.	Molar.	Canine.	Incisor.	Incisor.	Incisor.	Incisor.	Canine.	Molar.	Molar.
Upper.	20–24	15–21	16–20	8–10	8–10	8–10	8–10	16–20	15–21	20–24
Lower.	20–24	15–21	16–20	15–21	6–9	6–9	15–21	16–20	15–21	20–24

The order of their appearance is, first, the lower central incisors; then the upper central incisors, closely followed by the laterals; then the lower laterals; next the upper anterior molars followed by the lower; then the upper canines followed by the lower; finally, the lower back molars, followed by the upper.

Describe the order of appearance of the permanent teeth.

The first to appear are the first molars at the end of the sixth year, the lower teeth usually preceding the upper; thus, expressed in *years*, these teeth erupt as follows:

	Wisdom.	Molar.	Molar.	Bicuspid.	Bicuspid.	Canine.	Incisor.	Incisor.	Incisor.	Incisor.	Canine.	Bicuspid.	Bicuspid.	Molar.	Molar.	Wisdom.
Upper .	18–30	13–16	7	11	10	11–13	9	8	8	9	11–13	10	11	7	13–16	18–30
Lower .	17–25	12–13	6	10	9	11–12	8	7	7	8	11–12	9	10	6	12–13	17–25

Describe the development of the teeth.

The enamel is derived from the ectoderm; the dentin, cementum, and pulp from the mesoderm. A *linear thickening* of oral epithelium appears before the sixth week; next follows a lateral (labial) projection, the *dental ridge*, growing into the mesoderm, forming a furrow on the oral surface, the *dental groove of Goodsir.* The positions of the future teeth are marked by local thickenings under the ridge, the *dental bulbs*, which become the *enamel organs* of the temporary teeth; the dental ridge atrophies; these primitive enamel organs become invaginated like an epithelial cap over a mesodermic *dental papilla*, embracing about two-thirds of it; the cap shows three layers—the external, of one or two rows of low columnar cells, the *outer enamel cells;* they are reflected to form the inner invaginated layer of the organ, the *inner enamel cells.* These two layers are separated at first by a middle layer, which undergoes great changes: a network is formed, reduced to thin plates, fluid collects (*enamel pulp*), and finally all disappears. At the sides of the primitive organs the *second enamel organ* develops the permanent teeth. The inner layer above produces enamel, *enamel membrane.* The top and sides of the dental papillæ are covered by *odontoblasts*, whose processes are *dentinal fibers;* the canals left are *dentinal tubules*, homologues of the canaliculi of bone. The central part of a dental papilla remains as *pulp-tissue.* The *cementum* is formed last of all from an epithelial sheath, but not in fetal life, and increases to old age. By the gradual growth of the fang the crown produces absorption by pressure upon the overlying bone and mucous membrane, when *eruption* occurs.

The Mouth.

What is the mouth?

It is an ovoid cavity in which food is masticated, bounded by the lips in front, by the cheeks and alveolar processes of both jaws with their contained teeth at the sides, by the hard palate above, by the tongue and floor of the mouth below, and behind by the soft palate and the anterior pillars of the fauces where it opens into the pharynx; it is lin
brane covered by scaly stratified e
ous racemose glands, continuo
gin of the lips; it present

The *hard palate*, for

rior maxillary and palate bones covered by the intimately adherent periosteum and mucous membrane furnished with palatal glands.

The *soft palate*, consisting of a fold of mucous membrane depending from the posterior border of the hard palate, enclosing muscular tissue, an aponeurosis, adenoid tissue, mucous glands, etc.; the muscles on each side are five, the levator and tensor palati, palato-glossus, palato-pharyngeus, and azygos uvulæ—the latter with its fellow forming the median projecting conical *uvula.*

Anterior and posterior pillars of the fauces, the former containing within a fold of mucous membrane the palato-glossus muscle on each side, arching downward and forward from the palate to the base of the tongue; the latter, the palato-pharyngei muscles, passing backward and downward to the sides of the pharynx.

Isthmus faucium is the space bounded by the pillars of the fauces and tonsils, base of the tongue, and free margin of the soft palate.

Tonsils[7] (Fig. 114), situated between the anterior and the posterior pillars on each side, consisting of glandular tissue containing twelve to fifteen openings leading into crypts lined with mucous membrane, external to which is a layer of closed capsules analogous to those of Peyer's glands; the tonsil is only separated from the internal carotid artery by the superior constrictor muscle.

Openings of the ducts of Stensen, opposite the second upper molar tooth on each side, delivering the secretion of the parotid glands.

Openings of the ducts of Wharton, one on either side of the frenum of the tongue, delivering the secretion of the submaxillary glands.

Openings of the ducts of the sublingual gland (*ducts of Rivinus*), from eight to twenty in number; they open on an elevated crest of the mucous membrane on each side of the frenum linguæ, one or more joining in a tube opening into Wharton's duct called the *duct of Bartholin.*

What are the salivary glands?

Three compound racemose glands on each side. The *parotid*, the largest, lies below and in front of the ear between the zygoma above, mastoid behind, and ramus of the jaw in front—its duct is *Stensen's;* the *submaxillary* lies below the jaw in the anterior part of the submaxillary triangle—its duct is *Wharton's;* the *sublingual* lies beneath the mucous membrane of the floor of the mouth against the jaw, close to the symphysis—its ducts are those of *Rivinus.*

Describe the tongue.

Its base is attached to the hyoid bone and lower jaw by muscles, to the epiglottis by two lateral and one median

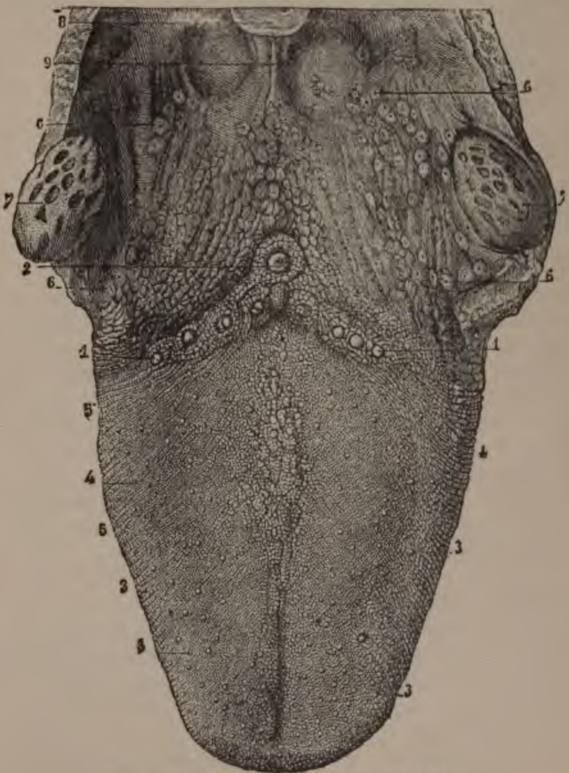


FIG. 114.—Dorsum of the tongue (Leidy).

glosso-epiglottic folds of mucous membrane, and to the soft palate by the anterior pillars; its tip, sides, dorsum, and part of the under surface are free; a median raphé and fibrous septum divide the organ into halves; its mucous membrane reflected over the floor of the mouth to the gums forms in front an antero-posterior fold, the *frenum linguæ;* the tongue is formed by certain *intrinsic muscular fibers*, viz. those of the lingualis, and by *extrinsic muscles*, the stylo-glossus, hyo-glossus, genio-hyo-glossus, and palato-glossus (see p. 148). The mucous membrane of the tongue presents the

Circumvallate papillæ, numbering eight to ten, arranged on the back part of the dorsum in two lines converging behind like a letter V; just behind the junction is a little recess, the *foramen cæcum*[2], prolonged in the fetus by the *thyro-glossal duct* to the pyramidal process of the thyroid gland.

Fungiform papillæ[3], scattered over the dorsum, but chiefly found at the sides and apex.

Filiform or *conical papillæ*[4], with secondary papillæ projecting from their apices, arranged in lines cover the anterior two-thirds of the dorsum of the tongue.

Racemose *lingual glands*[a], situated along the sides, but chiefly over the posterior third of the dorsum; some secrete mucus, others serum.

Lymphoid tissue, collected into masses or *follicles*, exhibits crypts; one collection far back is called the *lingual tonsil.*

Name the blood-supply.

This is from the:

Lingual { *Dorsalis linguæ*, *Sublingual*, *Ranine*,
Ascending pharyngeal,
Facial, by the submental branch anastomosing with the sublingual.

Describe the nerve-supply.

The *lingual branch of the fifth* is distributed to the papillæ at the front and sides to the extent of two-thirds of its surface, endowing these parts with general sensation; the *chorda tympani* has the same distribution, and seems to be the nerve of taste to this region.

Lingual branch of the glosso-pharyngeal, supplying the mucous membrane of the base and sides and circumvallate papillæ or posterior third; it is the nerve of taste and sensation for these parts.

Hypoglossal, to the muscles; the motor nerve.

Superior laryngeal sends a few filaments to the base near the epiglottis from its internal branch; thus, five nerves supply each side.

What anatomical points of surgical interest does the palate present in the vicinity of the last molar tooth?

Just behind this tooth the *hamular process* and the *internal pterygoid plate* can be felt, the point for division of the tensor palati aponeurosis in the operation for cleft palate; and in front of this to the inner side of the last molar tooth is the *posterior palatine artery* as it emerges from the canal, sometimes requiring plugging after a cleft-palate operation; in resection of the inferior dental nerve, locate the last molar tooth, enter the mucous membrane and find the lingula on the ramus of the jaw which is just above and anterior to the nerve.

The Pharynx.

What is the pharynx?

A conical musculo-membranous sac, about five inches long, extending from the under surface of the base of the skull to a point corresponding to the cricoid cartilage or sixth cervical vertebra. It is widest opposite the aperture of the larynx, narrowest below, where it terminates in the esophagus; it is bounded *above* by the basilar process and body of the sphenoid; is connected *posteriorly* with the cervical vertebræ, longus colli and recti capitis antici muscles; *anteriorly* it is incomplete, opening into the mouth, being attached to the internal pterygoid process, pterygo-maxillary ligament, lower jaw, tongue, hyoid bone and larynx; since it lies behind the nose, mouth, and larynx, it should be described in three parts —*nasal*, *oral*, *laryngeal; laterally*, it is attached to the styloid processes and muscles arising from them, while the common and internal carotid arteries, the internal jugular veins, ninth, tenth, twelfth, and sympathetic nerves here lie in contact with it. The *cavity* has seven openings: the two posterior nares, two Eustachian tubes, mouth, larynx, and esophagus. A considerable mass of lymphoid tissue extends across the back of the pharynx, between the orifices of the Eustachian tubes, called the *pharyngeal tonsil;* a recess in the mucous membrane always exists in the fetus, the *pharyngeal bursa,* which passes up to the pharyngeal spine; behind the opening of the Eustachian tube is the *fossa of Rosenmüller;* from the end of the tube descends a *salpingo-pharyngeal fold* of mucous membrane, covering in the *salpingo-pharyngeus muscle.*

Of how many coats does it consist?

Three: an internal *mucous,* continuous with that lining the mouth, etc., covered with ciliated epithelium down to the level of the floor of the nares, below by squamous epithelium, containing racemose glands most plentiful around the orifices of the Eustachian tubes, and much lymphoid tissue surrounding crypts, called the *tubal tonsils;* a middle *fibrous coat* (*pharyngeal aponeurosis*), thick above, where the muscular fibers are wanting; and an external *muscular coat* composed of the superior, middle, and inferior constrictors, stylo-pharyngeus, palato-pharyngeus, and salpingo-pharyngeus muscles.

Describe the pharyngeal muscles (Fig. 115).

Inferior constrictor[8]: *origin,* side of the cricoid and thyroid cartilages; *insertion,* unites with its fellow; *action,* constricts the pharynx during swallowing; *nerves,* pharyngeal plexus, from glosso-pharyngeal, external laryngeal, recurrent laryngeal, spinal accessory.

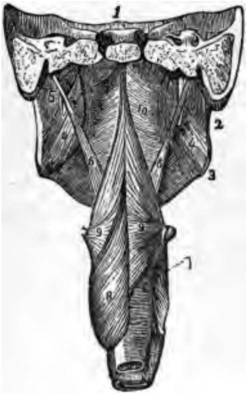


FIG. 115.—Muscles of the pharynx, posterior view.

Middle constrictor[9]: *origin,* greater and lesser cornua of the hyoid bone and stylo-hyoid ligament; *insertion,* unites with its fellow; *action,* same as above; *nerves,* glosso-pharyngeal, spinal accessory through the pharyngeal plexus.

Superior constrictor[10]: *origin,* lower third of the margin of the internal pterygoid plate and hamular process, contiguous surface of the palate bone, reflected tendon of the tensor palati muscle, pterygo-maxillary ligament, alveolar process above the posterior end of the mylo-hyoid ridge and side of the tongue; *insertion,* posterior median raphé and pharyngeal spine of the occipital bone; *action*, same as the other constrictors; *nerve*, spinal accessory through the pharyngeal plexus.

Stylo-pharyngeus[6]: *origin*, inner side of the base of the styloid process; *insertion*, blends with the constrictor muscles, and is also inserted into the posterior border of the thyroid cartilage; *action*, draws the sides of the pharynx upward and outward; *nerve*, glosso-pharyngeal.

What arteries supply the pharynx?

Superior thyroid, *Tonsillar*,
Ascending pharyngeal, *Pterygo-palatine*,
Ascending palatine, *Descending palatine.*

What are its nerves?

Branches from the pharyngeal plexus, formed by the pharyngeal branches of the glosso-pharyngeal, pneumogastric, external laryngeal, all derived from the spinal accessory and sympathetic nerves.

The Esophagus.

Describe it with coats, vessels, and nerves.

It is a muscular canal, nine or ten inches long (23–26 cm.), joining the pharynx and stomach, commencing at the lower border of the cricoid cartilage, passing through the esophageal opening of the diaphragm, to terminate at the cardiac orifice of the stomach, opposite the eleventh thoracic vertebra; it has three parts: the *cervical*, to the opening of the thorax; the *thoracic*, from the second thoracic vertebra to the tenth; the *abdominal*, about one inch long below the diaphragm; it has three curves, one antero-posterior and two lateral; in the *neck* it lies between the trachea and the spinal column and longus colli muscle, at the lower part inclining to the left, having on either side the common carotid artery, with the lateral lobes of the thyroid gland—the recurrent laryngeal nerves ascend between it and the trachea; in the *thorax*, after passing behind the aortic arch, it runs to the right of the vessel, to pass in front and to the left again before piercing the diaphragm.

It has three coats: internal *mucous*, when empty thrown into longitudinal folds, containing numerous glands, its surface being studded with small papillæ, and covered by squamous epithelium; at its lower end the next coat is the *muscularis mucosæ;* a middle *areolar* coat loosely connects the mucous and the succeeding coat; a *muscular*, composed of an external longitudinal and internal circular layer, the fibers *above* consisting chiefly of the striated, but *below* almost entirely of the unstriped involuntary variety.

The *arteries* are from the inferior thyroid, thoracic aorta, left inferior phrenic, and coronary of the stomach; they have a ongitudinal direction.

The *veins* empty into the inferior thyroid, azygos minor, and coronary of the stomach; the portal and the general system meet on the esophagus.

The *nerves* are from the esophageal plexus, formed by the pneumogastric and recurrent laryngeals, with some sympathetic filaments.

The Stomach.

Describe it.

The stomach is a pear-shaped dilatation of the alimentary canal connecting the esophagus with the small intestine. Its larger end points above and to the left; its smaller, below and to the right. The mouth of the stomach receiving the esophagus is called the *cardia.* To the left and below this is the *fundus*, forming about one-fifth of the stomach; this continues on the right into the *body of the stomach*, which has two surfaces included between two borders; the *anterior surface* looks upward and forward, the *posterior*, downward and backward; the *lesser curvature* is concave above and to the right, and is attached to the liver by the lesser omentum; the *greater curvature* is convex, turned to the left and downward, and gives attachment to the great omentum. At the right and lower end of the stomach the body contracts into the *pyloric portion*, which presents two or three bulging parts, each one called the *pyloric antrum;* these pouches are caused by the short *pyloric ligaments.* The external constriction between the stomach and the duodenum is the *pyloric sulcus*, made by a muscular ring, the *pyloric sphincter;* an internal projection of the mucous membrane is produced, called the *pyloric valve* or *pylorus.* The *peritoneum* related consists of the lesser, great, and gastro-splenic omenta, and a gastro-phrenic ligament.

Dimensions and Position.—Length, ten to twelve inches; vertical diameter, four to five inches; antero-posterior, three and one-half inches; distance between the two orifices, three to six inches. Luschka's measurements of the same lines are: 34 cm., 15 cm., 3.7 to 11.5 cm. Weight is four and one-half ounces; capacity, five to eight pints.

The stomach lies in the epigastrium and the left hypochondrium; five-sixths are to the left of the median line; only a small part of the pyloric portion is on the right side. It lies under the liver and diaphragm, above the jejunum, ileum, and colon, and extends from the spleen to the gall-bladder.

The cardia lies one inch (2–3 cm.) below the esophageal opening in the diaphragm, 11 cm. from the anterior body-wall; this point is also opposite the seventh left chondro-sternal junction or the eleventh thoracic vertebra—three landmarks. The fundus is 3–5 cm. higher up, at the sixth left chondro-sternal junction. Pylorus reaches the upper border of the first lumbar vertebra on the right side. Lowest edge of the greater curvature in the median line reaches a point two fingers' breadth above the umbilicus.

Relations: above and *anteriorly*, diaphragm, anterior parts of the seventh, eighth, and ninth ribs, thoracic and abdominal walls, left part of the under surface of the liver; *posteriorly*, diaphragm and its left crus, aorta, inferior vena cava, celiac axis, lesser sac of the peritoneum, transverse colon, and splenic flexure, transverse meso-colon (upper layer), part of the spleen, splenic vessels, pancreas, left kidney and capsule; at the *left end* are the spleen and diaphragm.

How many coats has the stomach?

Four, as follows:

Serous, derived from the peritoneum covering all parts except along the greater and lesser curvatures, where the omenta leave triangular spaces, along which pass the vessels and nerves.

Muscular, consisting of three sets of fibers: the *longitudinal*, continuous with the longitudinal coat of the esophagus and small intestine, more distinct along the lesser curvature; the *circular fibers* form a continuous layer beneath the former set, most abundant at the pyloric end, forming the sphincter; the *oblique fibers*, some passing obliquely from left to right, others *vice versa*, around the cardiac orifice; the *submucous coat* consists of areolar tissue supporting the vessels.

Mucous, covered with columnar epithelium, and thrown into longitudinal folds or *rugæ* when the stomach is empty, covered by small, shallow, polygonal-shaped alveoli from 0.12 mm. to 0.25 mm. in diameter; they are the mouths of the tubular glands.

The *gastric glands* are of three kinds: the *cardiac* (not called peptic) are lined throughout with columnar epithelium, consisting of a duct into which open two or three cecal tubes; beneath the epithelium lie large, spheroidal, granular, *parietal cells;* these glands are found in all parts of the stomach.

Pyloric glands, found in greatest numbers at the pyloric end, resemble the preceding, but are *without* the large parietal cells, and the cecal tubes are shorter and more numerous.

Lenticular glands or *lymphoid follicles* exist in early life, consisting of masses of lymphoid tissue like a solitary gland.

Give the blood- and nerve-supply.

The five *arteries* are: *coronary*, *pyloric*, *right gastro-epiploic* of the *hepatic*, *left gastro-epiploic*, and *vasa brevia* from the splenic.

The *veins* end in the splenic, superior mesenteric, gastric, and portal veins.

The *nerves* are the terminal branches of both pneumogastrics and numerous branches from the sympathetic of the solar plexus.

The Small Intestine.

Describe it (Fig. 116).

It is the narrowest part of the digestive tract, is a convoluted tube twenty-two feet long, occupying the central and lower parts of the abdominal and pelvic cavities, and is suspended from the spine by a fold of peritoneum called the *mesentery;* its three divisions are the

Duodenum[2], ten to twelve inches long, with three types, *circular*, or *infantile*, U-*shaped*, and V-*shaped*, passing upward and backward to the right to the under surface of the liver and gall-bladder—*superior curve*—then descending in front of the right kidney—*descending portion*—thence running transversely across the third or fourth lumbar vertebra—*transverse portion*—

to end in the jejunum on the left side of the first or second lumbar vertebra—*ascending portion*—a *fifth portion* is sometimes described, about one inch long, which arches forward to join the jejunum. It is only partially covered by peritoneum, has no mesentery, and surrounds the head of the pancreas; into the descending portion, to the inner side, pass obliquely the common bile and pancreatic ducts.

Jejunum[3], so called because usually empty after death, includes the upper two-fifths of the remainder of the small intestine, and lies chiefly in the umbilical region and left iliac fossa.

Ileum[4] includes the remainder (three-fifths) of the small intestine, is named from its numerous coils, occupies chiefly the umbilical, hypogastric, right iliac, and occasionally pelvic regions, and opens into the inner side of the commencement of the large intestine in the right iliac fossa; the orifice is guarded by a two-leaved *ileo-cecal valve*, or *valve of Bauhin.*

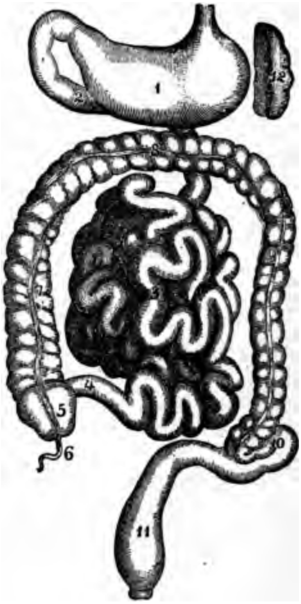


FIG. 116.—The intestinal canal. (Leidy.)

What coats has the small intestine?

The same as the stomach—mucous, submucous, muscular, and serous.

The *mucous membrane* is covered with columnar epithelium, and forms transverse folds encircling the tube for one-half or two-thirds of its circumference, forming the

Valvulæ conniventes; they are absent in the first two inches of the duodenum and almost disappear in the lower part of the ileum; *villi* cover the surface, formed of a central lacteal vessel accompanied by unstriped muscular tissue, an encircling plexus of capillaries, lymphoid tissue, and granular corpuscles, all enclosed by a basement-membrane supporting columnar epithelium: their number is estimated at four million; the

Submucous coat connects the mucous with the muscular coat, and contains the intestinal vessels and nerve-plexuses; the

Muscular coat externally is composed of longitudinal and internally of circular fibers, forming complete rings.

Describe the glands of the small intestine.

They are:

Brunner's glands, resembling the salivary in structure, are limited to the duodenum and commencement of the jejunum.

Crypts, or *glands of Lieberkühn*, are minute tubular depressions lined with columnar epithelium, found in both intestines, small and large.

Solitary glands, most numerous in the lower part of the ileum, but found in all parts, consist of masses of lymphoid tissue like a lymph-node, 0.6 mm. to 3 mm. in diameter.

Peyer's glands or *patches* are twenty to thirty ovoidal patches composed of numerous solitary glands (hence named *agminated glands*), situated opposite to the mesenteric attachment, their long axis lengthwise, and are largest and most numerous in the ileum, although occasionally seen in the jejunum and duodenum; the valvulæ conniventes and villi cease at the margins of the patches.

Name the blood-vessels and nerves.

The *arteries* are the pyloric and from the gastro-duodenal of the hepatic and superior mesenteric; the *veins* chiefly empty into the portal system; the *nerves* are from the superior mesenteric plexus of the sympathetic.

The Large Intestine.

Describe it[5], [7], [8], [9] (Fig. 116).

It extends from the ileum to the anus, is five or six feet long, large and sacculated, and has the same coats as the small intestine; the mucous coat is destitute of villi, but is thrown into crescentic folds by the longitudinal muscular fibers, which are disposed in three bands (tænia), shorter than the other coats, so forming them into pouches.

Describe the subdivisions of the colon.

They are the *cecum*[5], or *caput coli*, the dilated commencement of the large bowel situated in the right iliac fossa, and usually wholly covered by peritoneum.

The *appendix vermiformis*[6], a narrow, blind-ended, worm-like tube, from three to six inches long, springing from the lower back part of the cecum, held in no set position by a peritoneal fold.

The *ileo-cecal valve* (or Bauhin's) is formed by two horizontal semilunar folds of mucous membrane at the termination of the ileum in the cecum, opening toward the large intestine and guarding against reflux *from* the large *into* the small bowel; the mucous folds are reinforced by circular muscular fibers, and the surfaces toward the ileum are covered with villi, while these are absent on the cecal side.

The *ascending colon*[7] extends up from the cecum in front of the right kidney, to the under surface of the liver to the right of the gall-bladder, where, abruptly bending to the left, it forms the *hepatic flexure;* it is almost—sometimes entirely—enveloped in peritoneum, in which latter event it has an *ascending meso-colon* (26 per cent.).

The *transverse colon*[8] traverses the abdomen from right to left, just below the liver, stomach, and spleen, to the left hypochondriac region, where it curves downward beneath the lower end of the spleen, forming the *splenic flexure;* it has a wide transverse *meso-colon,* attaching it to the spine and pancreas.

The *descending colon*[9] passes down in front of the left kidney to the left iliac fossa and is only partially covered with peritoneum, its posterior surface usually being free; the descending meso-colon is rare.

The *sigmoid flexure*[10], the narrowest part, lies in the left iliac fossa extending from the descending colon at the crest of the ileum to the left sacro-iliac synchondrosis; it is curved like an S, and is held in place by a loose peritoneal fold, the *sigmoid meso-colon.*

The *rectum*[11] extends from the left sacro-iliac articulation to the anus, is from six to eight inches long, curves slightly to the right and then adapts itself to the sacral curve, and at the apex of the prostate gland inclines backward to the anus; it is non-sacculated, but just above the anus presents a dilatation, or *ampulla;* it is only covered with peritoneum to its second portion, forming a *meso-rectum;* it leaves it wholly
flected upon the bladder or uterus, three and

(8 cm.) from the anal orifice. The rectum has three parts: the *first* continues from the sigmoid to the third sacral vertebra; the *second* from there to the apex of the prostate gland; the *third portion* is the *anal canal*, one inch long.

The *appendices epiploicæ* are little peritoneal pouches filled with fat placed along the colon and upper part of the rectum.

What guards the anal orifice?

The sphincter ani, a voluntary muscle, and the internal sphincter, the continuation of the circular muscular coat.

What are the folds of Houston?

Three semilunar folds of mucous membrane, one on the right side of the rectum or *third sphincter;* two more are on the left side, one above the level of the right fold, and one below.

Name the glands of the large intestine.

Crypts of Lieberkühn and *solitary glands.*

Give the blood- and nerve-supply of the large intestine and rectum.

The *arteries* are branches of the *superior* and *inferior mesenteric*, the *middle hemorrhoidal* from the internal iliac, and the *inferior hemorrhoidal* from the internal pudic, and a few more from the sciatic.

The *veins* empty into the portal system, except the inferior hemorrhoidal.

The *nerves* come from the sympathetic plexuses around the mesenteric arteries, and, in the case of the rectum, the fourth anterior sacral nerve and internal pudic supply the sphincter ani muscle.

The Liver.

Describe it (Figs. 117 and 119).

It occupies the right hypochondrium extending across the epigastrium into the left hypochondrium to the mammary line. It is the largest gland in the body, weighing from three to four pounds; its transverse diameter is eleven inches (28 cm.), its antero-posterior eight (20 cm.), its greatest vertical five to seven inches. Covered by peritoneum, except at the attachments of the ligaments, it possesses a *fibrous coat*, covering the whole organ continuous with the *capsule of Glisson* at the transverse fissure; there are three surfaces, an anterior border, right and left ends, five fissures, five lobes, five ligaments, and five sets of vessels.

Superior surface is convex, smooth, lying in contact with the diaphragm above, and below with a small portion of the abdominal wall; it is divided into two unequal lobes by a peritoneal fold, the *suspensory*, *broad*, or *falciform ligament;* the *Inferior surface* is concave, is in relation with the stomach, duodenum, hepatic flexure of the colon, right kidney, and suprarenal capsule, and is divided by the *left longitudinal fissure*[8],[9], into a right and a left lobe.

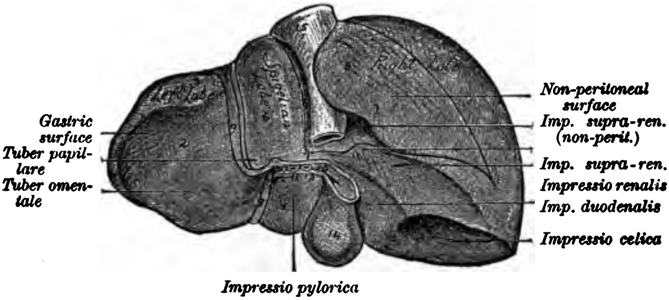


FIG. 117.—Posterior and inferior surfaces of the liver.

The *posterior surface*[3],[3] is rounded and grooved, presents a margin of the left lobe, a groove for the esophagus, the ligamentum venosum in the fissure of the ductus venosus[9], the Spigelian lobe, a fossa for the vena cava, a small non-peritoneal surface for part of the right suprarenal capsule, and a large one for the diaphragm.

Anterior border[4] is thin, sharp, and deeply notched at the site of the round ligament and of the gall-bladder at the ninth costal cartilage; it corresponds usually with the margins of the ribs in males, projecting a little lower in women and children.

Describe the ligaments.

They are five in number (really ten), four being composed of folds of the peritoneum; the fifth is the obliterated umbilical vein; the

Suspensory or *broad ligament* (falciform) is a **falciform antero-posterior** peritoneal fold, with its apex backward, **attached** *to the liver* from the notch on the anterior border to the coronary ligament—its anterior free edge enveloping the round ligament—and to the *diaphragm* and sheath of the right rectus muscle as low as the umbilicus; the

Coronary ligaments consist of two layers reflected from the diaphragm on the upper and lower margins of the posterior surface of the organ, between which firm areolar tissue binds the liver to the diaphragm; the

Lateral ligaments, right and left triangular, are prolongations on each side of the two layers of the coronary, which unite and extend from the diaphragm to the adjacent posterior surface of the liver.

Round ligament, a fibrous cord, ascends from the umbilicus in the anterior free margin of the broad ligament to the longitudinal fissure, traceable back to the vena cava; the posterior portion is the remains of the ductus venosus, the anterior of the umbilical vein.

Describe the fissures.

They are five in number, dividing the posterior and inferior surfaces of the organ into five lobes; they resemble the letter H.

Left longitudinal fissure[8,9] extends from the notch on the anterior border, inferiorly and posteriorly to the posterior margin of the superior surface, separating the right and left lobes, and is joined by the *transverse fissure*[10]; the anterior portion of the fissure is called the *umbilical fissure* from lodging the fetal umbilical vein; posterior portion, the *fissure of the ductus venosus*, lodging the obliterated fetal vessel; either part is often partially bridged over by the *pons hepatis*.

Transverse fissure[10], *porta hepatis*, or *hilum*, is two inches long and one-half inch wide, passing transversely across the under surface of the right lobe between the two longitudinal fissures; here enter the portal vein, hepatic artery, and nerves, and the bile-ducts and lymphatics emerge.

Fissure of the gall-bladder[14], *fossa vesicalis*, lies parallel and to the right of the umbilical fissure reaching back nearly to the transverse fissure.

Fossa for the vena cava is short and deep, sometimes converted into a canal; it separates the Spigelian from the right lobe, and is separated from the transverse fissure by the caudate lobe; the hepatic veins here empty into the vena cava. These two fossæ form an interrupted *right longitudinal fissure.*

Describe the lobes of the liver.

They are five in number; the

Right lobe[1], the largest, of a quadrilateral form, its surfaces being superior, inferior, and posterior, marked by three fissures, viz. transverse, one for the gall-bladder, and one for the inferior cava, which separate three more lobes; four *impressions* are seen on the under surface; posteriorly, the *renal* and *suprarenal;* anteriorly, one for the *colon;* internally, one for the *duodenum.*

Left lobe[2], smaller and flattened, resting by its inferior concave surface on the stomach, presenting a prominence, the *tuber omentale.*

Lobus quadratus[5] is marked off from the under surface of the right lobe by the transverse fissure behind, by that for the gall-bladder on the right, and anterior part of the longitudinal fissure on the left.

Lobus Spigelii[6] projects from the posterior surface of the right lobe, bounded in the front by the transverse fissure, on the right by that for the vena cava, and on the left by the fissure of the ductus venosus.

Lobus caudatus[7] is a small elevation running obliquely outward from the base of the lobus Spigelii to the under surface of the right lobe; it intervenes between the right end of the transverse fissure and the commencement of that for the vena cava.

Describe the vessels of the liver.

They number five, hepatic artery, portal vein, hepatic veins, hepatic duct, and the lymphatics; the first three are enveloped in loose areolar tissue called the *capsule of Glisson*, which accompanies the vessels through the *portal canals* in the interior of the organ.

Portal vein[11] (vein of the gate), about four inches long, collects blood from the viscera of digestion; it is formed by the junction of the superior mesenteric and splenic veins, the latter receiving the blood returned by the inferior mesenteric vein, while the cystic and two gastric veins empty into the portal vein itself. Entering the transverse fissure it divides into branches for the right and the left lobes, which receive the *vaginal* and *capsular* veins, and subdividing form the ***interlobular veins***[b] (Fig. 118), which send branches to the interior of each lobule, forming a plexus converging to empty into the central *intralobular vein*[a] running at right angles to other vessels; the intralobular vein empties into a *sublobular vein*, a radicle of the hepatic vein; the

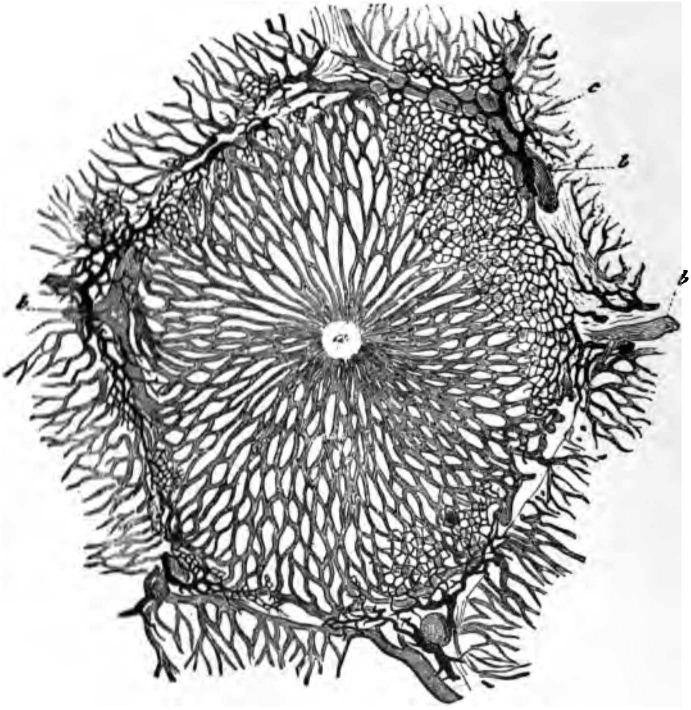


FIG. 118.—Cross-section of a lobule of the liver (Leidy).

Hepatic veins commence in sublobular veins as just described, which unite to form three large and several smaller branches terminating in the inferior vena cava in the fissure for that vessel.

Hepatic artery[12] springs from the celiac axis, enters the transverse fissure, and divides into branches which ramify in the capsule of Glisson; *vaginal*, supplying nutriment to the vessels, ducts, etc.; *capsular* to terminate in the external fibrous coat; *interlobular* pass to the interlobular plexus on the outer surface of each lobule; doubtful if any branches enter the capillary network between the cells.

Hepatic duct[13] is formed by the union of two bile-ducts of nearly equal size which emerge from the transverse fissure, one from the right, the other from the left lobe; it passes downward to the right for one to two inches, to be joined by the *cystic duct* from the gall-bladder, forming the ductus communis choledochus.

Lymphatics consist of a superficial or subperitoneal and a deep or interlobular set accompanying the blood-vessels, emerging with the hepatic veins and at the portal fissure.

Whence do the nerves of the liver come?

From the solar plexus of the sympathetic and from the left pneumogastric; the phrenics supply part of the external surface.

Describe the liver structure.

It is composed of numerous lobules from one-twentieth to one-tenth of an inch in diameter, of irregular form in the human liver, polygonal in pigs, their bases clustered round the sublobular vein, to which each is connected by its intralobular vein; the lobules are bound together by loose areolar tissue; each lobule consists of nucleated *hepatic cells*, spheroidal or many-sided, with nucleoli, measuring from one two-thousandth to one one-thousandth of an inch, containing granular yellow coloring-matter and globules, which cells lie in the meshes of the dense capillary network occupying its interior; spaces between the cells form the *intercellular biliary passages*[c], bile-canaliculi, the radicles of the bile-ducts.

What is the capsule of Glisson?

The areolar tissue which surrounds the three vessels in the right free margin of the lesser omentum, entering the transverse fissure, forms *portal canals* for the same vessels to their ultimate ramifications, and is continuous with the fibrous coat of the organ. In a section of liver-tissue the portal may be distinguished from the hepatic veins by the fact that the former are collapsed, being surrounded by the capsule of Glisson, while the hepatic are held open, being closely connected with the liver-substance.

Describe the gall-bladder[14].

It is a pear-shaped, fibro-muscular receptacle for the bile ; its fundus and under surface of the body and neck are covered by peritoneum, while its interior is lined with a cylindrical-celled, epithelial-coated mucous membrane, presenting a honeycombed appearance from the confluence of numerous minute rugæ ; its length is from three to four inches, its capacity from eight to twelve fluidrachms, and it lies in a fossa on the under surface of the liver, its *fundus*—most dilated portion—projecting slightly beyond the anterior border, touching the abdominal wall just below the ninth costal cartilage; the narrow *neck* curves upon itself like an italic *f*, to terminate in the *cystic duct*, which is one to three inches long, and is lined by mucous membrane so disposed in a series of crescentic folds as to present the appearance of a *spiral valve*, which is called the *valve of Heister;* the cystic duct joins the hepatic duct to form the common bile-duct.

Describe the ductus communis choledochus[13] (Fig. 117).

It is about three inches long, three-sixteenths of an inch in diameter, and is formed by the junction of the hepatic and cystic ducts; it opens usually by a common orifice with the pancreatic duct, from a small sac of mucous membrane and *papilla Vateri* a little below the middle of the inner side of the descending portion of the duodenum; its walls are composed of fibrous with a little muscular tissue, its mucous membrane is covered with columnar epithelium, and it runs between the layers of the gastro-hepatic omentum.

What are the relations of the liver?

Antero-superiorly, diaphragm, right and left lungs, pericardium and heart, anterior abdominal wall, six or seven right lower ribs ; *inferiorly*, right kidney and capsule, hepatic flexure of colon, duodenum, gall-bladder and cystic duct, vessels at the transverse fissure, stomach; *posteriorly*, diaphragm and crura, tenth and eleventh thoracic vertebræ, esophagus, aorta, inferior vena cava, thoracic duct.

The Pancreas.

Describe the pancreas[9] (Fig. 119).

It is a compound racemose gland, of pyramidal shape, about six inches long, one and a half inches wide, and one inch thick, lying behind the stomach and in front of the second lumbar vertebra. It is composed of lobules connected by areolar tissue, each lobule consisting of an ultimate branch of the

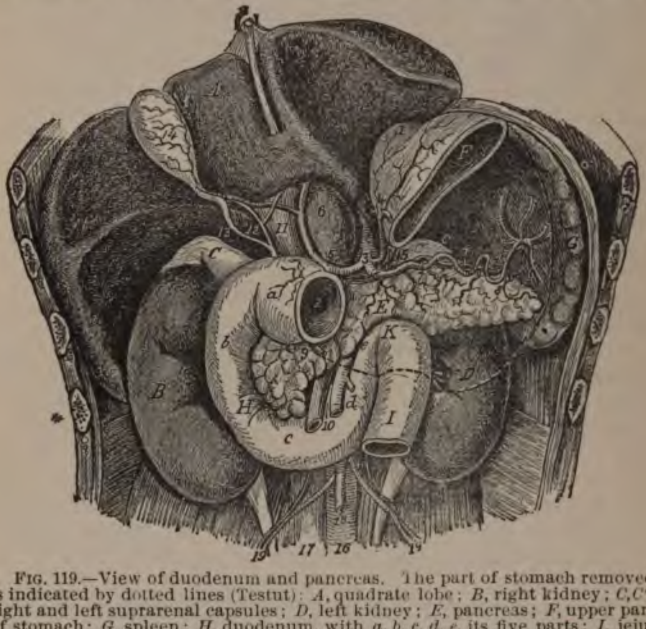


FIG. 119.—View of duodenum and pancreas. The part of stomach removed is indicated by dotted lines (Testut): *A*, quadrate lobe; *B*, right kidney; *C*,*C′*, right and left suprarenal capsules; *D*, left kidney; *E*, pancreas; *F*, upper part of stomach; *G*, spleen; *H*, duodenum, with *a*, *b*, *c*, *d*, *e*, its five parts; *I*, jejunum; *K*, duodeno-jejunal angle. 1, lower end of esophagus; 2, pyloric orifice; 3, celiac axis; 4, coronary artery; 5, hepatic artery; 6, Spigelian lobe of liver; 7,7′, splenic vessels; 8, left gastro-epiploic artery; 9, right gastro-epiploic artery; 10, superior mesenteric vessels; 11, portal vein: 12, hepatic duct; 13, cystic duct; 14, gall-bladder: 15, left crus of diaphragm; 16, aorta; 17, vena cava inferior; 18, inferior mesenteric vessels; 19, spermatic vessels.

duct lined with columnar epithelium, terminating in cecal pouches or acini, also lined with cylindrical epithelium, outside of which is a fine capillary network; the

Pancreatic duct (*canal of Wirsung*) extends the whole length of the gland and opens into the descending part of the duodenum, to the inner side, with the common bile-duct; the

Head, or *right extremity*, is embraced by the concavity of the duodenum, the common bile-duct lying behind, the superior and inferior pancreatico-duodenal arteries in front. A part of the head may curve behind the superior mesenteric vessels and be partially detached, the *lesser pancreas.* The *tail*, or *left extremity*, reaches the spleen either across the upper end of the left kidney and capsule or across the center of the kidney, touching same part of the spleen in each case. The *neck* is one inch long, constricted between the first and last portions of the duodenum. The *body* is triangular on section, with its apex forward, placed at the point of separation of the two layers of the transverse mesocolon; it presents three surfaces, *anterior*, *posterior*, and a narrow *inferior*, and three borders, *superior*, *anterior*, and *inferior*. *Relations: above*, first part of the duodenum, celiac axis, solar plexus, splenic and hepatic arteries, left lobe of the liver; *in front*, lesser sac, stomach, pancreatico-duodenal arteries, transverse colon, upper layer of the transverse mesocolon; *below*, duodenum, jejunum, transverse colon, lower layer of the transverse mesocolon, superior mesenteric vessels, inferior mesenteric vein, mesentery; *behind*, second lumbar vertebra, pancreatic and common bile-ducts, aorta, vena cava, origin of the thoracic duct, vena portæ, crura of the diaphragm, solar plexus, superior mesenteric artery, right and left renal vessels, left kidney and capsule; spleen at the left end, curve of the duodenum at the right end.

The *arteries* are derived from the hepatic, splenic, and superior mesenteric; *veins* are of the same names and empty into the portal system; *nerves* come from the solar plexus. In structure the pancreas resembles the parotid gland.

The Ductless Glands.

What are the ductless glands?

The spleen, suprarenal capsules, thyroid and thymus glands, bodies whose functions are uncertain and which have no ducts.

The spleen and suprarenal capsules lie in the abdominal cavity, but the glands will be for convenience described after the spleen.

The Spleen (Figs. 116 and 119).

Describe it.

It is a soft, brittle, very vascular, oblong, flattened organ embracing the fundus of the stomach, to which it is attached by the gastro-splenic omentum, which completely invests the spleen, except at the hilum and where the suspensory ligament is attached; the organ lies deeply in the left hypochondrium, and has three surfaces, *phrenic*, *basal*, and *internal*, and three borders.

Outer phrenic surface is convex, smooth, lying in contact with the diaphragm, which separates it from the ninth, tenth, and eleventh ribs; the

Inner surface is concave, presents the *hilum* and *intermediate border* separating a posterior *renal surface* from an anterior *gastric surface.*

Hilum is a vertical fissure pierced by blood-vessels, lymphatics, and nerves.

Basal surface bounds the lower end of the spleen, touches the pancreas, rests on the splenic flexure of the colon and on the phreno-colic ligament.

Anterior border is often notched; the *posterior border* is rounded and in relation with the left kidney; the

Suspensory ligament, a peritoneal fold, connects it with the under surface of the diaphragm.

The *sustentaculum lienis* (supporter of the spleen) is the *phreno-colic ligament*, which passes from the diaphragm opposite the anterior ends of the tenth and eleventh ribs to the splenic flexure of the colon.

Relations: externally and *above*, peritoneum and diaphragm, ninth, tenth, and eleventh ribs, costo-phrenic sinus, left lung and pleura, left lobe of the liver (at birth), muscles of the back; *internally*, stomach, left kidney and capsule, tail of the pancreas; *inferiorly*, tail of the pancreas sometimes, splenic flexure of the colon, phreno-colic ligament.

Fibro-elastic coat, beneath the serous, which intimately adheres to it, forms the framework of the spleen, passing inward at the hilum with the vessels as sheaths, from which, and the inner surface of the capsule, numerous bands or *trabeculæ* pass, uniting to form numerous small spaces or *areolæ* filled with the splenic pulp.

Describe the spleen-pulp and Malpighian bodies.

It is of a dark reddish-brown color, and under the microscope is seen to consist of a network of branched connective-tissue cells, containing pigment-granules (broken-down blood-corpuscles), granular matter, nucleated cells, free nuclei, and red blood-cells in all stages of disintegration; the

Splenic artery[20] (Fig. 119) is large, tortuous, and divides at the hilum into five or six branches which do not anastomose to any extent, each branch breaking up again and again into smaller ones, until they terminate in bundles of straight vessels which open into the interstices of the reticulum formed by the branched connective-tissue cells.

The *Malpighian bodies* are small, rounded, expanded masses of the lymphoid tissue of the external coat of the small splenic arteries, from one one-hundredth to one twenty-fifth of an inch in diameter, usually surrounding the vessel, but sometimes projecting from one side; they are composed of a delicate reticulum packed with lymph-corpuscles and pervaded by capillaries; the

Splenic vein arises from the *lacunar* spaces in the pulp, has free anastomoses, and empties into the portal vein; the

Nerves are derived from the right pneumogastric nerve, the right and left semilunar ganglia, the solar plexus, and attend the arteries.

Lymphatics form two sets, *trabecular* and *perivascular.*

The Thyroid Gland.

Describe it.

It consists of two lateral lobes situated at the sides of the upper portion of the trachea, connected at about their lower thirds by a narrow transverse portion, the *isthmus*, which is occasionally absent. A third lobe, the *pyramid*, sometimes springs from the left upper side of the isthmus, or the left lobe, and extends to the hyoid bone; it is at times detached; occasionally a slender muscular band—the *levator glandulæ thyroideæ*—extends from the hyoid bone to the isthmus or the pyramid. Structurally, the gland consists of a connective tissue capsule, sending in septa subdividing the organ into lobes, each of which is formed of numerous closed vesicles filled with a viscid yellowish fluid embedded in connective tissue containing a dense vascular plexus surrounding the vesicles.

Two *parathyroid glands* are described as constant in man and other mammals, each lying near a lateral lobe of the thyroid.

What arteries supply this gland?

The *superior* and the *inferior thyroid* branches respectively of the external carotid and the thyroid axis, and at times the *thyroidea ima*, springing either from the innominate artery or the aortic arch itself, to pass up on the front of the trachea. These vessels are remarkable for their size and frequent anastomoses.

Describe the veins of the thyroid gland.

They form a plexus on the surface of the gland, whence arise the

Superior thyroid vein,
Middle thyroid vein, } Emptying into the internal jugular vein.
Inferior thyroid vein opening into the innominate vein.

Name the nerves.

Branches of the middle and inferior cervical ganglia.

The Thymus Gland.

Describe it.

It is a temporary organ of unknown function, reaching its full development at the end of the second year, after which it gradually atrophies, having nearly disappeared at puberty. When fully developed it extends from the fourth costal cartilage to the lower border of the thyroid gland, consisting of two lateral lobes in close contact along the middle line, while sometimes an intermediate lobe exists; the sternum and origins of the sterno-hyoid and sterno-thyroid muscles cover it, as it lies in the neck behind these muscles upon the front and sides of the trachea; it rests, in the mediastinum, upon the pericardium, the thoracic fascia separating it from the aortic arch and great vessels. Its dimensions are: length, two inches; breadth, one and a half inches; thickness, one-quarter of an inch; at birth it weighs about half an ounce.

Describe its structure.

It is formed of numerous lobules bound together by delicate areolar tissue, all being inclosed by a fibrous capsule; the lobules are composed of a *cortical* lymphoid tissue, and a *medullary* portion containing a few lymphoid cells, but toward the center granular cells and concentric corpuscles exist. Each follicle is surrounded with a capillary plexus.

Describe the arterial and nerve-supply.

The *arteries* are derived from the internal mammary, superior and inferior thyroid, subclavian and carotid.

The *veins* empty into the thyroids and left innominate.

The *lymphatics* are large and arise from an interlobular plexus in the substance of the gland, and are said to empty into the internal jugular veins.

The *nerves* are very minute, coming from the pneumogastric and sympathetic; the descendens cervicalis and phrenic probably reach the capsule.

The Suprarenal Capsules.

What are they?

Two triangular or semilunar flattened bodies, situated behind the peritoneum, immediately above and in front of the upper part of each kidney; the right one is triangular, the left, crescentic and larger. They consist of a thin, closely adherent *fibrous capsule*, which sends numerous communicating partitions inward, a *cortical* and a *medullary portion;* the former contains columns of finely granular polyhedral cells, with channels between them and the fibrous portions, believed to be lymph-sinuses; the *medullary portion* is formed of stout connective-tissue bundles between which lie coarsely granular columnar and branched cells, which have been thought to communicate with a very fine nerve-plexus found in the medulla.

With what parts do these organs lie in contact?

The *anterior surface* of the *right capsule* touches the under and back surfaces of the right lobe of the liver, is partly covered by the inferior vena cava, and at the internal inferior angle is crossed by the hepatic curve of the duodenum; *posteriorly* it lies on the diaphragm.

The *left capsule* has *in front* the peritoneum of the lesser sac, stomach, spleen, upper border of the pancreas, splenic artery; *posteriorly* is the left crus of the diaphragm. They are related by their inner margins to the great splanchnic nerves and semilunar ganglia, on the right side touching the inferior vena cava, and on the left side the left crus of the diaphragm.

Name its vessels and nerves.

The *arteries* are from three sources: the suprarenal and branches of the inferior phrenic and renal arteries forming a dense capillary network in the interior; the

Venous capillaries return blood from the medullary venous plexus by a single *suprarenal vein* which empties into the inferior cava on the right side, and on the left into the renal vein.

Nerves are very numerous, chiefly distributed to the medulla, and are derived from the solar and renal plexuses and the phrenic and pneumogastric nerves, having developed upon them numerous small ganglia, hence the opinion held by some that these bodies belong to the sympathetic nervous system.

The Abdominal Cavity.

What is the abdomen?

An ovoidal cavity, limited above by the diaphragm, below by the brim of the true pelvis; in front and at the sides by the lower ribs, abdominal and iliac muscles; behind, by the vertebral column, psoas, and quadratus lumborum muscles; it is lined with peritoneum—a serous membrane—which is reflected to form partial or complete investments for the contained organs or *viscera.*

Name the abdominal viscera.

Stomach,
Intestines,
Liver,
Gall-bladder,
Spleen,
Pancreas,
Kidneys,
Suprarenal capsules,
Aorta,
Inferior vena cava,
Thoracic duct,
Receptaculum chyli,
Bladder if distended,
Uterus if enlarged.

Describe the openings in its walls.

They are the *umbilical* for the *fetal* umbilical vessels, obliterated after birth, leaving a depression, the *umbilicus; opening for the inferior vena cava* in the diaphragm; *aortic* *opening*, behind the diaphragm between the crura, for the aorta, vena azygos major, thoracic duct, and sometimes the left sympathetic nerve; *esophageal opening* in the diaphragm for the esophagus and pneumogastric nerves; *internal abdominal ring*, on each side, for the spermatic cord in the male, round ligament in the female; *lacuna vascularis*, on each side below Poupart's ligament for the transmission of the femoral vessels and crural branch of the genito-crural nerve, showing internally the *femoral* or *crural ring*, the site of the femoral hernia.

Into what regions is the abdomen artificially divided?

Into nine, by two imaginary parallel lines encircling the body on a level with the ninth costal cartilages and summits of the iliac crests, and two other parallel lines drawn from the cartilage of the eighth rib on each side to the center of Poupart's ligament.

Quain takes as the upper horizontal line, *infracostal*, between the lowest points of the thoracic border, usually the tenth costal cartilages; the inferior horizontal line, *bi-iliac*, unites the most prominent (not highest) points of the iliac crests; this line cuts the fifth lumbar vertebra and is one and one-quarter inches below the summits of the crests; vertical lines are *mid-Poupart.* Morris advises the same line above and the *interspinous line* below, connecting the anterior superior spinous processes of the ilia, also the vertical mid-Poupart lines. Joessel's horizontal lines are *infracostal* and *interspinous; vertical*, ascend to the upper horizontal line from the ilio-pectineal eminences (Fig. 120). This marks off three horizontal zones, *epigastric*, *mesogastric*, and *hypogastric.*

The right lateral regions are, from above downward (see cut), the

Right hypochondriac, which contains the right lobe of the liver, gall-bladder, hepatic flexure of the colon, and upper part of the right kidney.

Right lumbar, contains the ascending colon, lower part of the right kidney, and some coils of the small intestine (ileum).

Right inguinal (*iliac*), contains the cecum, often the appendix vermiformis, and end of the ileum.

The median regions are:

Epigastric, contains part of the right lobe of the liver, greater part of the left lobe, part of the gall-bladder, stomach, middle and pyloric portions, both orifices, first two parts of the duodenum, duodeno-jejunal junction, pancreas, except the tail, upper part of the spleen, part of the kidneys, suprarenal capsules.

Umbilical, contains the transverse colon, part of the great omentum and mesentery, transverse portion of the duodenum,

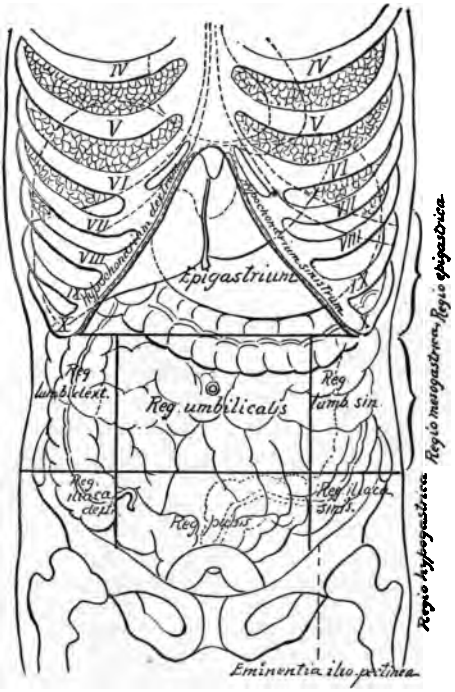


FIG. 120.—Regions of the abdominal cavity, anterior view (after Joessel).

and some coils of the jejunum and ileum, part of both kidneys with ureters, and the receptaculum chyli.

Hypogastric, contains coils of the small intestine, the bladder in children, or when distended in adults, ureters, the uterus during the latter months of pregnancy, often the cecum, appendix vermiformis, sigmoid flexure of the colon, and the upper part of the rectum.

The left lateral regions from above downward are:

Left hypochondriac, contains the fundus of the stomach, greater part of the spleen, tail of the pancreas, splenic flexure of the colon, upper part of the left kidney, and part of the left lobe of the liver.

Left lumbar, contains the descending colon, part of the omentum, sigmoid flexure, lower part of the left kidney, and some coils of the jejunum.

Left inguinal (*iliac*), contains the sigmoid flexure of the colon and convolutions of the jejunum and ileum.

The Peritoneum.

Describe it (Fig. 121).

A serous membrane, forming a closed sac (in the *male*), the layer covering the walls being called the *parietal*, and that reflected over the viscera the *visceral* layer; it is coated with a layer of flattened endothelium, its attached surface being connected with the subjacent parts by the subperitoneal areolar tissue or fascia.

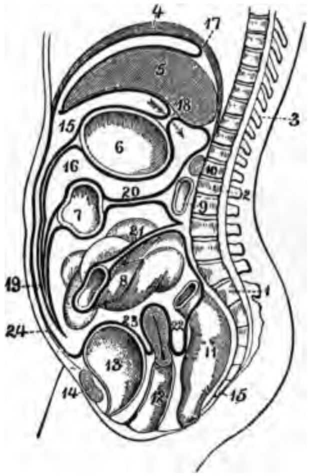


FIG. 121.—Diagram to illustrate the reflections of the peritoneum in the female body (Leidy).

Does the peritoneum always form a closed sac?

No; in the female the Fallopian tubes open into its cavity.

How is the peritoneum divided for convenience of description?

Into the *greater sac*[15], or that covering the upper anterior portion of the liver[5], the stomach[6] in front and above, descending over the ileum forming the anterior layer of the great omentum[15], the under layer of the mesocolon[20], the mesentery[21], and reflections[23] upon and between the rectum[11], the uterus in the female[22], and the bladder[13], then lining the antero-lateral abdominal walls to reach, from the under surface of the diaphragm[17], the upper surface of the liver, the starting-point of this description (see Fig. 121).

The *lesser cavity*, or *cavity of the great omentum*[16], starting from the diaphragm behind, passes over the Spigelian lobe of the liver[18], then covers the back and under surface of the stomach[6], forms the inner layer of the great omentum[16], passes over the colon[7] completing the mesocolon[20], and thence passes over the pancreas[10] and great vessels to line the posterior abdominal wall, reaching the point started from; the two cavities communicate through the foramen of Winslow.

Describe the foramen of Winslow[18].

It is the orifice of communication between the greater and the lesser sacs, admitting two fingers; bounded above by the caudate lobe of the liver, below by the first part of the duodenum and hepatic artery, in front by the right free border of the lesser omentum, containing the hepatic artery, common bile-duct, and vena portæ; behind by the inferior vena cava.

What are the omenta?

They are folds of peritoneum connecting the stomach with the other viscera, four in number, viz. the

Gastro-hepatic, or *lesser omentum*[18], extending between the transverse fissure of the liver, lesser curvature of the stomach, and beginning of the duodenum, consisting of two layers, the anterior belonging to the greater, the posterior to the lesser sac, which enfold at the right free border of the omentum, the *hepatic artery*, *common bile-duct*, *portal vein*, *lymphatics*, and *hepatic nerve-plexus;* this border is called the *hepato-duodenal ligament.*

The *great omentum*[19] is formed of four layers, two descending, one from the anterior, the other from the posterior wall of the stomach, and uniting below to pass as low as the pelvis, when they ascend to the transverse colon, separate and embrace this part of the bowel, and pass to the pancreas as the transverse mesocolon. At about the age of two years the two anterior layers of the great omentum become adherent to the transverse colon; the part between the stomach and colon is then called the *gastro-colic omentum.*

Gastro-splenic omentum is a double fold connecting the spleen with the stomach, contains the vasa brevia of the splenic artery, and is continuous below with the great omentum.

What are the mesenteries?

Double layers of peritoneum embracing various portions of the intestinal tube connecting them to the vertebral column or posterior abdominal walls; between the folds run the vessels of the part attached. They are called the

Mesentery^{21}, *mesocecum*, *mesocolon*^{20}, *mesorectum*, *mesogastrium.*

What are the ligaments?

Ligament is a term applied to the folds connecting the viscera usually not belonging to the intestinal canal and abdominal walls, such as

The *gastro-phrenic* to the cardia of the stomach from the diaphragm.

The *longitudinal*, *two lateral*^{17}, and *coronary* ligaments of the liver.

The *vesical*, five so-called false ligaments.

Two *vesico-uterine*^{23}, two *recto-uterine*^{22}, two *broad ligaments* of the uterus.

Suspensory ligament of the spleen connecting this organ with the diaphragm; also the *supporting ligament* or *phreno-colic.*

Mention the viscera wholly $(^{1})$ and partially $(^{2})$ covered with peritoneum, and those totally deficient $(^{3})$ in such investment.

(1) The *spleen*, *small intestine*^{8}, *cecum*, *transverse colon*^{7}, *sigmoid flexure*, *ovaries*, *uterus*, *stomach*^{6} and *liver*^{5} practically, *duodenum* (first part), *rectum*^{11} (first part).

(2) *Duodenum*^{9} (descending and transverse),
Ascending colon,
Descending colon,
Rectum (second part^{11}),
Vagina^{12} (upper part),
Bladder^{13} (posterior surface).

(3) *Rectum*^{11} (lower part),
Bladder^{13} (base, anterior surface),
Pancreas^{10},
Kidneys,
Suprarenal capsules,
Vagina (lower and anterior portion).

ORGANS OF VOICE AND RESPIRATION.

The Larynx.

What is the larynx[1] (Fig. 122)?

The voice-organ, formed of cartilages united by ligaments, the segments enjoying movement upon one another, which is effected by numerous muscles.

Mention the component cartilages.

There are nine, three being single and three in pairs:

Thyroid cartilage[1],	*Two arytenoid cartilages*[7],
Cricoid cartilage[5],	*Two cuneiform cartilages*,
Epiglottis,	*Two cornicula laryngis.*

Describe the thyroid (**shield-like**) **cartilage.**

It consists of two *alæ*[2], or lamellæ, united at an acute angle in front, forming a vertical ridge, whose more prominent upper portion is called the *pomum Adami*[1], or Adam's apple; the

Inner surfaces of the alæ are smooth, giving attachment in front, at the receding angle formed by their junction, to the epiglottis, true and false vocal cords, thyro-arytenoid and thyro-epiglottidean muscles.

The *outer surface* affords attachment along an oblique ridge to the sterno-thyroid and thyro-hyoid muscles, below and behind to the inferior constrictor muscle.

The *upper border* presents a deep, median notch[1], and is slightly concave on either side.

The *lower border* is connected medianly with the cricoid cartilage by the crico-thyroid membrane, and on each side by the crico-thyroid muscle.

The *posterior* borders are thick, rounded, and terminate above and below on each side in *cornua*, the two *superior*[3] having attached to their apices the lateral thyro-hyoid ligaments, while the *inferior*[4] articulate internally by an oval facet with the cricoid cartilage; to this border are also attached the stylo-pharyngeus and palato-pharyngeus muscles.

Describe the cricoid (**ring-like**) **cartilage.**

It is placed with its narrow portion[6], *annulus*, in front and the broad *lamina*[5] behind, has on each side two articular facets, one on the upper margin behind for the arytenoid cartilage, one externally near the lower margin for the inferior cornu of the thyroid cartilage.

The *upper border* gives attachment in front and at the sides to the crico-thyroid membrane; at the sides to the lateral crico-arytenoid muscles and inferior constrictor of the pharynx.

The *lower border* is horizontal and connected with the first tracheal ring by a fibrous membrane.

The *posterior surface* presents a median vertical *ridge*, the *linea eminens*, for the attachment of the longitudinal fibers of the esophagus, and on each side a *fovea* for the attachment of the posterior crico-arytenoid muscle.

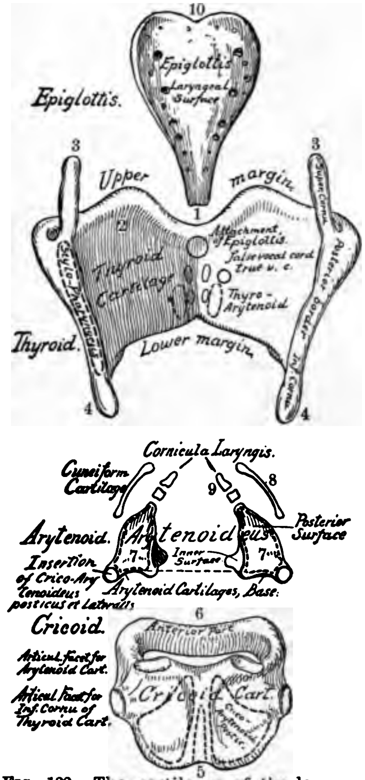


FIG. 122.—The cartilages of the larynx; posterior view.

Describe the two arytenoid (pitcher-like) cartilages[7].

They are pyramidal in form, and are placed on the upper border of the cricoid; each has three surfaces and three borders, a base, and an apex.

Posterior surface of each is triangular and concave, and affords attachment to the arytenoideus muscle;

Antero-external surface is convex, presents the *fossa triangularis*, and has attached the thyro-arytenoid muscle and false vocal cord;

Internal surfaces face each other, covered by mucous membrane;

Base presents a concave, smooth articular facet for the cricoid cartilage and two prominent angles;

External angle has attached to it the posterior and lateral crico-arytenoid muscles; it is called the *muscular process;*

Anterior angle, the *vocal process*, has attached to it the true vocal cord;

Apex curves backward and inward and articulates with a corniculum laryngis.

Describe the cornicula laryngis[9] (cartilages of Santorini).

They are two small conical cartilaginous nodules surmounting the apices of the arytenoid cartilages, affording attachment to the aryteno-epiglottic folds.

Describe the cuneiform cartilages[8] (cartilages of Wrisberg).

They are elongated cartilages contained in the free borders of the aryteno-epiglottic folds just in front of the cornicula.

Describe the epiglottis[10].

It is a thin, leaf-shaped lamella of *fibro-cartilage*, attached by its apex to the reëntering angle of the thyroid cartilage just below the median notch; it lies at the base of the tongue, in front of the upper opening of the larynx, and during deglutition shuts like a lid over the laryngeal orifice. Its

Base is free, rounded, curving forward toward the base of the tongue.

Apex is attached to the receding angle of the thyroid by the *thyro-epiglottic ligament.*

Anterior surface is covered with mucous membrane reflected on to the sides and base of the tongue, forming three *glosso-epiglottic folds;* externally on each side may be a *pharyngo-epiglottic fold;* a median elastic structure connects this surface with the posterior surface of the hyoid body, the *hyo-epiglottic ligament.*

Posterior surface shuts down over the laryngeal opening during deglutition; it presents a prominence called the *tubercle* or *cushion.*

Lateral margins give attachment to the aryteno-epiglottic folds.

How are the ligaments of the larynx divided?

Into *extrinsic*, or those connecting the thyroid cartilage and epiglottis with the hyoid bone, and cricoid cartilage with the trachea; and *intrinsic*, those binding the various cartilages together.

Name the extrinsic ligaments.

Thyro-hyoid membrane, *middle* and *two lateral thyro-hyoid ligaments*, containing a small cartilaginous or bony nodule, *cartilago triticea; thyro-* and *hyo-epiglottic ligaments*, *crico-tracheal membrane.*

Name the intrinsic ligaments.

The *intrinsic articulations* of the larynx are four: *crico-thyroid* below, *crico-arytenoid* above, each possessing a ligamentous capsule and synovial sac. The strengthening bands of the crico-thyroid joint are the *anterior*, *postero-superior*, and *postero-inferior kerato-cricoid ligaments.* The strengthening band of the crico-arytenoid joint is the *posterior crico-arytenoid* passing from below, upward and outward. Other ligaments are the two *superior* and two *inferior thyro-arytenoid* and *crico-thyroid membrane.*

What are the vocal cords?

The *superior* or *false vocal cords*, on each side, are two folds of mucous membrane enclosing the superior thyro-arytenoid ligaments composed of elastic tissue, stretching between the angle of the thyroid cartilage below the epiglottis and anterior surfaces of the arytenoid cartilages; the lower margin forms the upper free crescentic margin of the ventricle of the larynx.

The *true* or *inferior vocal cords* are two strong, yellow elastic fibrous tissue bands, the inferior thyro-arytenoid ligaments, covered by thin, tightly adherent mucous membrane, which pass from the receding angle of the thyroid to the anterior angles of the arytenoid cartilages, the upper border forming the lower margin of the ventricle of the larynx, the lower continuous with the lateral portion of the crico-thyroid membrane; each has the thyro-arytenoid muscle lying parallel externally; these cords or membranes produce sound by their vibrations; the false cords do not, although they indirectly influence vocalization.

What are the glottis and the rima glottidis?

The *glottis* is the narrow triangular interval between the true vocal cords in front, and between the arytenoids and the vocal processes behind; the *rima* is the boundary of the space.

Describe the ventricle of the larynx.

It consists of an oval depression or *sinus* on each side, between the true and the false vocal cords leading upward, external to the superior cord, into a cecal pouch, the *sacculus laryngis*, or *laryngeal pouch.*

Describe the sacculus laryngis.

It is a slightly curved conical membranous sac, situated between the inner surface of the thyroid cartilage and false vocal cord on each side; internally lined with mucous membrane, perforated by orifices of the ducts of sixty to seventy follicular glands lying in the submucous tissue; it is strengthened externally by a fibrous capsule continuous below with the superior thyro-arytenoid ligament, and has its inner (laryngeal) surface covered by the inferior aryteno-epiglottideus, and its external by the thyro-epiglottideus and thyro-arytenoid muscles, which compress the sacculus; the pouch is probably a remnant, and the function is resonance.

What kind of epithelium has the mucous membrane?

Above the false vocal cords squamous epithelium is found, except in front, where it is covered by ciliated columnar cells as high as the middle of the epiglottis; below the false cords only ciliated columnar epithelium is found.

Describe the muscles of the larynx and epiglottis.

Crico-thyroideus[2] (Fig. 123): *origin*, lower border of the thyroid and anterior border of the lower cornu; *insertion*, triangular into the antero-lateral surface of the cricoid cartilage; *action*, increases tension of the vocal cords by lifting the cricoid cartilage upward; *nerve*, superior laryngeal.

Crico-arytenoideus posticus: *origin*, lateral half of the posterior surface of the cricoid; *insertion*, outer angle of the base of the arytenoid cartilage; *action*, the two muscles by rotating the arytenoid cartilages outward open the glottis and tighten the cords; *nerve*, recurrent laryngeal.

Crico-arytenoideus lateralis: *origin*, upper border of the side of the cricoid; *insertion*, outer angle of the base of the arytenoid; *action*, by rotating the arytenoid inward it closes the glottis; *nerve*, recurrent laryngeal.

Thyro-arytenoideus: *origin*, lower half of the receding angle of the thyroid and crico-thyroid membrane; *insertion*, by an *outer* and an *inner portion* into the base, two angles, anterior surface of the arytenoid, and into both vocal cords; *action*, relaxes the vocal cords and compresses the sacculus laryngis; *nerve*, as above.

Arytenoideus has a *transverse* and two *oblique portions;* passes from the back surface and outer border of one arytenoid to the same part of the other cartilage; *action*, approximates the arytenoids closing the back of the glottis; *nerves*, superior and recurrent laryngeal.

Kerato-cricoideus, near the posterior crico-arytenoid: *origin*, from the lower border of the cricoid cartilage; *insertion*, inferior cornu of the thyroid cartilage; *action*, possibly steadies one cartilage upon the other; only occasionally found, and usually on one side.

Triticeo-glossus: *origin*, cartilage of the same name in the lateral thyro-hyoid ligament; *insertion*, tongue with the hyoglossus muscle; occurs on one or both sides; *action*, unknown.

Describe the muscles of the epiglottis.

Thyro-epiglottideus: *origin*, inner surface of the thyroid cartilage; *insertion*, aryteno-epiglottic fold, margin of the epiglottis, outer surface of the sacculus laryngis; this may be described as a part of the thyro-arytenoid muscle; *action*, depresses the epiglottis; *nerve*, recurrent laryngeal.

Aryteno-epiglottideus superior: *origin*, apex of the arytenoid cartilage; *insertion*, aryteno-epiglottic fold; *action*, narrows the upper laryngeal orifice; *nerve*, recurrent laryngeal..

Aryteno-epiglottideus inferior: *origin*, arytenoid cartilage above the superior vocal cord; *insertion*, part of the epiglottis and inner surface of the laryngeal pouch; *action*, compresses the sacculus laryngis; *nerve*, recurrent laryngeal.

Mention the arteries and veins of the larynx.

The *arteries* are laryngeal branches of the superior and inferior thyroids, and dorsalis linguæ for the epiglottis.

The *veins* empty into the superior, middle, and inferior thyroids, and the lingual.

What nerves supply the larynx?

The *superior*, and *inferior* or *recurrent laryngeal*, branches of the pneumogastric, the former derived largely from the accessory part of the spinal accessory and superior cardiac sympathetic nerves.

Superior laryngeal is chiefly a nerve of sensation, supplying the laryngeal mucous membrane and arytenoid muscles by its *internal laryngeal* branch, after piercing the thyro-hyoid membrane; and the *crico-thyroid muscle* by its *external laryngeal branch;* the

Recurrent laryngeal is the motor nerve supplying all the laryngeal muscles except the *crico-thyroid;* the right nerve descends in the neck to pass from before backward under the subclavian artery; the left winds in the same direction under the aortic arch, and both nerves ascend in the groove between the trachea and esophagus to their distribution, giving off in their course cardiac, esophageal, tracheal, and pharyngeal branches, and anastomosing with the superior laryngeal nerves.

The Trachea and Bronchi.

What is the trachea[3] (Fig. 123)?

It is a membranous, cylindrical air-tube, flattened posteriorly, of a transverse diameter of three-quarters to one inch (2 to 2½ cm.), length, four and one-half inches (10 to 11 cm.), extending from the lower part of the larynx (corresponding to the sixth cervical vertebra) to the disk between the fourth and fifth thoracic vertebræ, where it bifurcates to form the right and left bronchus; it is composed of sixteen to twenty imperfect cartilaginous rings surrounding two-thirds of the cylinder, enclosed in a double elastic fibrous membrane connecting the rings with one another, while the space behind has, within the membrane, a layer of longitudinal and another of transverse unstriped muscular fibers, the transverse being called the *trachealis muscle;* the last ring, by a triangular hooked process curving backward between the bronchi, forms two imperfect rings on either side for the right and left bronchus; the lining mucous membrane contains much lymphoid tissue and elastic fibers, and is covered by several layers of epithelium, the most superficial is columnar ciliated; *mucous glands* lie in the posterior part of the fibrous layer.

Give the relations of the trachea in the neck.

It is covered in *front* from above downward by

Anastomoses between the anterior jugular veins,
Isthmus of the thyroid gland,
Inferior thyroid veins,
Arteria thyroidea ima,
Cervical fascia,
Sterno-hyoid muscle,
Sterno-thyroid muscle,
Posteriorly, it lies upon the Esophagus,
Laterally, are
The common carotid arteries[13],
Lobes of the thyroid gland,
Inferior thyroid arteries,
Recurrent laryngeal nerves.

Describe its relations in the thorax.

It is covered from before backward by the

Manubrium of the sternum,
Remains of the thymus gland,
Left innominate vein,
Arch of the aorta,
Innominate artery,
Left carotid artery[12],
Deep cardiac plexus,
Sterno-hyoid muscle,
Sterno-thyroid muscle,
Posteriorly, lies the
Esophagus,
Laterally, *on each side*, the
Pneumogastric nerve and pleura.

What are the bronchi?

Two tubes, structurally like the trachea, extending from its bifurcation into the lungs, dividing and subdiving to form the bronchial tubes, in whose walls only scattered cartilaginous plates exist until the diameter .2 mm. ($\frac{1}{125}$ of an inch) is reached, when they become wholly membranous, while the muscular coat and the elastic fibrous coat then form a continuous circular layer around the smallest tubes; the mucous membrane is covered with ciliated columnar epithelium; the *right bronchus* is wider, shorter, and more horizontal than the left; it is one inch long (2.4 cm.), diameter, 2.2 cm., has five or six rings; the *left bronchus* is smaller, more oblique, and longer, two inches long (5.1 cm.), diameter, 2 cm., and has nine or ten rings.

Describe the relations of each bronchus.

The *right* begins opposite the fourth thoracic disk, enters the lung opposite the fifth thoracic vertebra, lying behind the superior vena cava and right auricle of the heart, having the right pulmonary artery at first below, then anterior to it, and the vena azygos major arching over it from behind.

The *left bronchus*, commencing at the same point as the right, passes in front of the esophagus, thoracic duct, and descending aorta beneath the aortic arch, the left pulmonary artery lying at first above, then in front of it to enter the lung opposite the sixth thoracic vertebra.

The left bronchus is *hyparterial;* the right gives off the *eparterial* branch, then each gives four ventral and four dorsal branches; the right has in addition an azygos branch. On the right the eparterial bronchus goes to the upper lobe, the first ventral to the middle lobe, the three lower ventral and all the dorsal to the lower lobe. On the left side the hyparterial bronchus, which is the first ventral, goes to the upper lobe; the other ventral and all the dorsal pass to the lower lobe.

What vessels and nerves supply the trachea and bronchi?

The *arteries* are tracheal branches of the inferior thyroid arteries and the bronchials from the aorta; the

Veins empty into the thyroid plexus and bronchial veins.

Lymphatics empty into the mediastinal glands.

Nerves are branches from the pneumogastric, recurrent laryngeal, and sympathetic.

The Lungs.

Describe them (Fig. 123).

They are the two organs of respiration, occupying the greater part of the thoracic cavity, separated by the heart and other contents of the mediastinum, covered by the pleuræ, of a specific gravity of 0.345 to 0.746, the right weighing twenty-two ounces, the left, twenty; in the ratio of 11 to 10. They are pinkish-white at birth, but irregularly marked by slate-colored patches as age advances from the deposit of carbonaceous matter in the lung-tissue (a condition called *anthracosis*); they are divided into lobes, the right lung having three[4],[5],[6], the left two[7],[8]; each lung has an apex, four surfaces, and two borders.

Apex, extending into the root of the neck above the first rib, about one to one and a half inches, where it is in relation with the first and second part of the subclavian artery, separated by pleura; the

Base or *phrenic surface* is broad and concave, resting upon the diaphragm, its thin margins extending lower down externally and behind than in front; the

External or *costal surface* is smooth, convex, marked by the interlobular fissures, and conforms to the shape of the thorax.

Inner or *mediastinal surface* is concave, and the left lung presents a depression in front for the heart; above and behind the center each presents the *hilum pulmonis*, for the attachment of the root of the lung; the

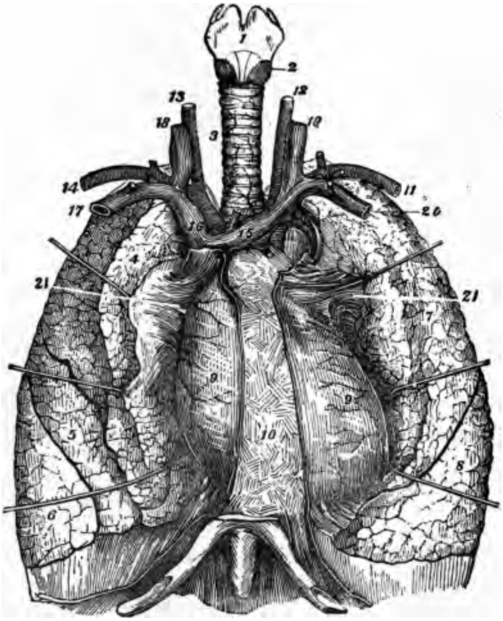


FIG. 123.—Anterior view of the larynx, trachea, lungs, and heart (Leidy).

Root[21] consists of a bronchus, pulmonary and bronchial arteries, pulmonary and bronchial veins and lymphatics, bronchial glands, anterior and posterior pulmonary plexuses, all connected by areolar tissue and enclosed by pleura; in front of each lies the phrenic nerve and anterior pulmonary plexus; behind, the pneumogastric nerve and posterior pulmonary plexus.

In what order are these various structures arranged?

From before backward;

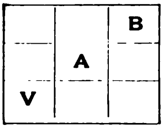
Both lungs:

Pulmonary veins,
Pulmonary artery,
Bronchus, etc.
} may be recalled by letters, V, A, B.

From above downward;

Right lung:

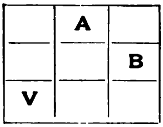
Bronchus,
Pulmonary artery,
Pulmonary veins.
} anterior



posterior

Left lung:

Pulmonary artery,
Bronchus,
Pulmonary veins.
} anterior



posterior

The *posterior surface*, often described as the border, is thick, rounded, and fits into the *sulcus pulmonalis* on each side of the vertebral column; this surface on the left lung shows a groove for the thoracic aorta, on the right lung a groove for the vena azygos major. A low ridge lies parallel to and behind the hilum, and anterior to the groove; this may be called the *posterior border* (Joessel). The *anterior border* is sharp and thin, overlaps the pericardium, and the left one presents a *notch* or *cardiac incisure.* The *inferior border* is the sharp margin surrounding the base of the lung, the greater part of which dips into a pleural recess above the costal attachments of the diaphragm.

The left lung is divided by the *left interlobular incisure* or *fissure* into two lobes; this fissure passes from the upper and back part of the hilum, upward and backward through the posterior surface, descends through the outer surface to the inferior border, a thumb's breadth from the anterior border, then passes up through the inner surface to the lower part of the hilum. The *lingual lobule* is included between this and the cardiac incisure. The right lung has two fissures and three lobes; the *right interlobular incisure* starts like the left one, is more vertical and reaches the inferior border a hand's breadth from the anterior border and passes up through the inner surface to the hilum; this main fissure separates the lower lobe from the upper and middle lobes. An additional fissure extends from about the center of the above nearly horizontally forward to the anterior border and thence on the inner surface to the hilum.

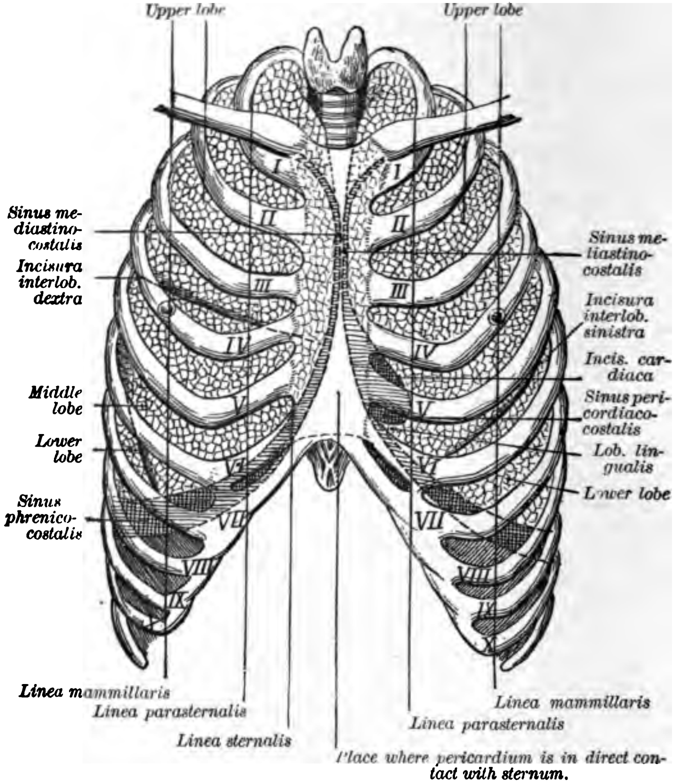


FIG. 124.—Relations of the lungs to the anterior chest-wall (after Joessel).

Describe the structure of the lungs.

They have externally a serous coat, a subserous areolar tissue penetrating between the lobules; lung-tissue is composed of the pulmonary substance or parenchyma, which is formed of an aggregation of *lobules*, each composed of a terminal bronchial tube with its air-cells, and ramifications of pulmonary and bronchial vessels, lymphatics, and nerves, thus forming a lung in miniature; they are pyramidal and large upon the surface, smaller and irregular in the interior; the *alveoli*, or *air-cells*, are small polyhedral alveolar recesses measuring about 0.25 mm. ($\frac{1}{100}$ inch) in diameter. The bronchi divide bipinnately into smaller and smaller *bronchioles* or *lobular bronchial tubes* which never anastomose; when the diameter is reduced to about 0.2 mm. their walls and mucous membrane change, little alveoli appear on a wall and finally cover it. At its end in a lobule, it divides into parts named from the plan of a Roman house (Fig. 125); first the *atrium* (entry) or *alveolar passage*, from which are given off blind pouches, *infundibula*, everywhere closely beset with air-cells; they are separated from one another by delicate membranous septa, between the layers of which lies the plexus formed by the pulmonary artery, thus exposing the blood to air *on two surfaces;* they are lined with a layer of squamous epithelium.

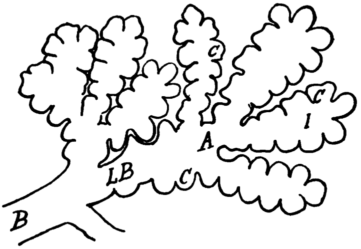


FIG. 125.—Diagrammatic representation of the termination of a bronchial tube in a group of infundibula: *B*, bronchial tube; *LB*, bronchiole; *A*, atrium; *I*, infundibulum; *C*, alveoli.

What are the vessels and nerves of the lungs?

They receive blood by the bronchial arteries for their own nutrition, and venous blood by the pulmonary artery for aëration—*i. e.* absorption of oxygen and emission of carbonic dioxid; the vessels are:

Bronchial arteries, branches of the aorta. *Pulmonary artery*, from the right side of the heart. The *bronchial vein* empties on the right side into the vena azygos major, on the left into the superior intercostal vein. The *pulmonary veins*, four in number, carry arterial blood to the left auricle.

Lymphatics, a superficial and a deep set, empty into the bronchial glands;

Nerves are derived from the anterior and posterior pulmonary plexuses, formed chiefly by branches from the sympathetic and pneumogastric nerves.

The Pleuræ.

Describe the pleuræ.

They are two closed serous sacs, not communicating with each other and wholly separated except anteriorly, leaving a space called the *mediastinum*. The right sac is shorter and wider than the left one.

The membrane reflected over the lungs to the roots is the *visceral layer*, or *pleura pulmonalis;* the part continuous with this and lining the inner surface of the thorax is the *parietal layer*, named, according to location, *pleura costalis*, also *phrenic*, *mediastinal*, *cervical*, and *pericardial pleura;* between the parietal and visceral layers is the *pleural cavity*, which does not exist unless made artificially or by disease, as the two layers lie in contact. Descending vertically along the inner surface of the lung from its root to the diaphragm is a double fold of pleura, the *broad pulmonary ligament* (*ligamentum latum pulmonis*).

In certain regions two parietal portions of the pleura may form a sharp angle or recess, into which the margin of the lung may or may not enter; it is a region between the extreme lung-limit and extreme pleural limit, called *pleural sinus*, or complemental space; *sinus phrenico-costalis*, or *costo-phrenic*, is the angle where the costal and phrenic pleuræ meet; *sinus mediastino-phrenicus* is antero-posterior on the upper surface of the diaphragm, near the middle line, and most marked where the pericardial pleura meets the phrenic; *sinus mediastino-costalis* is more or less vertical, is anterior and behind the sternum; *sinus pericardiaco-costalis* is between the pulmonary and pleural limits on the left side between the fourth and sixth costal cartilages, where the heart is not covered by the lung.

Describe the mediastinum.

It is the median space between the two pleural sacs, extending from the sternum to the vertebral column, containing all the thoracic viscera except the lungs.

It is divided into four parts, regarding the pericardium as a center: the *middle mediastinum* contains the pericardium and contents; the *anterior* is in front of it, *posterior* behind, and *superior* above.

The *superior mediastinum* is bounded below by a plane passing through the junction of the manubrium and gladiolus to the lower border of the fourth thoracic vertebra; in front of it are the manubrium and origins of the sterno-hyoid and sterno-thyroid muscles; behind are the four upper thoracic vertebræ and part of the longus colli muscles. It contains the trachea, esophagus, thoracic duct, arch of the aorta, innominate artery, thoracic parts of the left common carotid and left subclavian arteries, innominate vein, left superior intercostal vein, upper half of the superior vena cava, phrenic, pneumogastric, left recurrent, and cardiac nerves, lymphatic glands, and remains of the thymus gland.

The *anterior mediastinum*, placed obliquely, narrow above, is bounded in front by the gladiolus, triangularis sterni muscle, sometimes by the fifth, sixth, or seventh left costal cartilage; behind is the pericardium. Its contents are areolar tissue, lymphatic vessels, and two or three lymphatic glands.

The *middle mediastinum* contains the pericardium, heart, ascending aorta, pulmonary artery, lower half of the superior vena cava, arch of the vena azygos major, phrenic nerves and attendant arteries, bifurcation of the trachea, roots of the lungs, and the bronchial glands.

The *posterior mediastinum* lies between the pericardium, roots of the lungs and diaphragm in front, and the thoracic vertebral column behind, beginning at the fourth vertebra; it contains the thoracic aorta, esophagus, pneumogastric and splanchnic nerves, azygos veins, some right intercostal arteries, thoracic duct, and lymphatic glands.

Describe the topographical anatomy of the lungs and pleuræ.

The surface of the chest is marked off by certain transverse and vertical lines. Three levels are used for taking measurements of circumferences of the chest-wall: (1) at level of the highest points of the axillæ; (2) at level of the nipples; (3) at level of the sterno-xiphoid articulation (Fig. 124). Vertical lines are (1) the *linea mediana*, or mid-sternal line; (2) the *linea sternalis*, along each edge of the sternum; (3) the *linea mammillaris*, or *papillaris*, through the nipple; (4) the *linea parasternalis*, midway between sternal and mammillary lines; (5) the *linea axillaris* to the highest point of the axilla, also the *anterior* and *posterior axillary lines* from the anterior and posterior folds respectively; (6) the *linea scapularis*, drawn through the inferior angle of the scapula; (7) the mid-dorsal or *vertebral line*, drawn through the spinous processes of the vertebræ; (8) the *linea sterno-costalis* (costo-clavicular line), drawn from a sterno-clavicular articulation to the tip of the eleventh rib on the same side.

Measurements of the Thorax (Joessel).

	Perimeters.	
	Male.	Female.
At the level of the highest points of the axillæ	89.52 cm.	81.90 cm.
At the level of the nipples	86.64 cm.	81.00 cm.
At the level of the sterno-xiphoid articulation	81.88 cm.	78.00 cm.

Diameters: transverse, through the eighth or ninth ribs, 28 cm.; *antero-posterior*, at the base of the ensiform process, 20 cm.; *vertical* along the *posterior wall*, 31.5 cm.; *vertical* along the *anterior wall*, 15.5 cm.

The *internal sagittal diameter* is 1 cm. more than half the external, or 11 cm.; the *internal transverse diameter* is 1½ to 2 cm. less than the external.

Pleural limits: anteriorly the right and the left pleural margins pass from the sterno-clavicular articulations and meet behind the sternum at the junction of the manubrium and gladiolus; from the second to the fourth or fifth cartilages they are in contact or overlap; here the left layer usually deviates, and at the level of the sternal end of the fifth costal cartilage is 1.5 cm., at the sixth 2 cm., and at the seventh 3.5 cm., external to the left margin of the sternum; on the right side it descends to the level of the sixth costal cartilage in the midline;

At the *sternal line* the pleura on the right side crosses the upper margin of the seventh costal cartilage;

At the *parasternal line* it crosses the middle of the seventh costal cartilage;

At the *mammillary line* it crosses the lower margin of the seventh costal cartilage;

At the *midaxillary line* it crosses the ninth rib;

In the *vertebral region* it reaches the twelfth rib or the transverse process of the first lumbar vertebra. The limit on the left side may be a little lower than on the right, but clinically there is no difference.

Surface form of the lungs: the anterior borders of the lungs approach from the sterno-clavicular articulations, and almost meet behind the sternum on a level with the second costal cartilages; thence they descend together to the level of the fourth cartilages; the right margin passes nearly straight behind the sternum to the level of the sixth chondro-sternal articulation. The lowest *lung-limits* on the *right side* are:

At the *sternal line*, upper margin of the sixth costal cartilage;

At the *parasternal line*, lower margin of the sixth costal cartilage;

At the *mammillary line*, upper margin of the seventh rib;

At the *midaxillary line*, lower margin of the seventh rib;

At the *scapular line*, the limit crosses the ninth rib;

In the *vertebral region*, it reaches the eleventh rib.

At the fourth costal cartilage the anterior margin of the *left lung* slopes outward under its lower edge, crosses behind the fifth cartilage, and reaches a spot in the fifth space corresponding to the apex of the heart; the margin then curves inward, but not to reach the sternal line again. This space uncovered by the lung is the "area of superficial cardiac dulness."

The lower edge of the *lingual lobule* touches the sixth costal cartilage in the parasternal line and then the lowest lung-limit runs, as on the right side, to the eleventh rib. The height of the *costo-phrenic sinus* in quiet respiration is 2 cm. (four-fifths of an inch) at the sternal, parasternal, and mammillary lines, 6 cm. at the axillary, and 2.5 cm. in the vertebral region.

The *line of projection of the left interlobular incisure* on the chest-wall begins opposite the inner end of the spine of the scapula on the level of the spinous process of the third thoracic vertebra, then passes obliquely downward and forward to the outer end of the sixth costal cartilage. This marks the separation between the two lobes of the left lung.

The *right interlobular incisure* starts on the same level as that which marked the left one, descends obliquely over the posterior axillary line, crosses the inferior angle of the scapula, and reaches the inferior border of the lung at the mammillary line on the seventh rib.

The *middle incisure* starts at the point of intersection of the posterior axillary line with the "projection-line" of the main incisure just mentioned; it passes forward horizontally to the sternum, ending at the upper part of the sternal end of the fourth intercostal space. Above this line is the upper lobe of the right lung, between the fourth and sixth ribs is the middle lobe, and below the sixth rib is the lower lobe.

THE URINARY ORGANS.

Where are the kidneys situated?

Deeply in the loins, one on each side of the vertebral column, each kidney reaching from the upper border of the twelfth thoracic to the third lumbar vertebra, the right a little lower than the left; they lie embedded in a mass of fat behind the peritoneum, and enter four regions—the hypochondriac and epigastric above, the lumbar and umbilical below.

What are their size and weight?

Each measures about four inches in length, two and one-half in breadth, and one and one-quarter or one and one-half in thickness; they weigh, in the male, from four and one-half to six ounces; in the female, four to five and one-half ounces.

Describe their relations.

The *anterior surface of the right kidney* is in relation with the right lobe of the liver, descending duodenum, ascending colon, and the hepatic flexure.

The *anterior surface of the left kidney*, with the great end of the stomach, lesser sac, tail of the pancreas, and descending colon.

The *posterior surface* of each rests upon the crus of the diaphragm and the anterior layer of the lumbar fascia separating it from the quadratus lumborum and psoas magnus.

The *superior extremity* is embraced by the suprarenal capsule and the liver on the right side; by the capsule and the spleen on the left side.

The *inferior extremities* are two inches above the iliac crests.

The right *external border* is covered by the liver, the left by the spleen.

A fissure, or *hilum*, one inch long at the central portion of the *internal border*, opens into a cavity, the *sinus;* through it pass the *lymphatics*, also the *renal vein* in front, the *renal artery* next, and the *ureter*, or excretory duct, behind and below.

Describe the naked-eye appearances of a longitudinal section of a kidney (Fig. 126).

The kidney proper consists of a

Cortical substance[1], composed of convoluted and straight uriniferous tubules, blood-vessels, nerves, lymphatics, connective tissue, and Malpighian bodies, and is prolonged down between the pyramids, forming the *columns of Bertin;* a fibrous *capsule* envelops the organ, passes into the sinus which it lines, blending with the sheaths of vessels, nerves, and the calices; the

Medullary substance[2] consists chiefly of straight tubuli uriniferi, "Henle's loops," and blood-vessels, arranged in eight to eighteen *pyramids of Malpighi*[2'], whose apices are embraced by the calices of the pelvis of the ureter; the

Pelvis consists of eight *calices*, cup-like tubes, embracing the apices of eight to eighteen Malpighian pyramids, converging to form two *infundibula*, these again joining to form the *pelvis*, which gradually contracts into the *ureter* or *excretory duct.*

Describe the tubuli uriniferi[15] (Fig. 127).

They commence in a dilatation called the *capsule of Bowman*[1], which encloses a vascular *Malpighian tuft*, and terminate by opening on the free surfaces of the papillæ[15]. Next follows the *neck*, and the

Proximal convoluted tubule[3], the much convoluted portion after leaving the capsule of Bowman and situated in the cortical portion.

The *spiral tubule of Schachowa*[4], next succeeding, where the tubule approaches the medullary portion in a spiral manner; now entering the medullary portion, the tubule suddenly becomes smaller, quite straight, dipping down into the pyramids, as the *descending limb of Henle's loop;* forming a loop[5], it enlarges, ascends spirally, diminishes its caliber, and reënters the cortical substance, *ascending limb of Henle's loop*[7], [8]; next

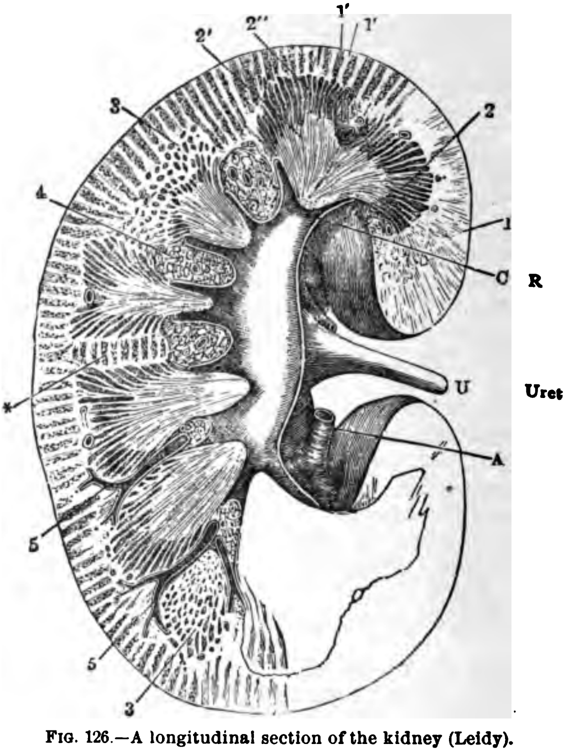


FIG. 126.—A longitudinal section of the kidney (Leidy).

it becomes angular, the *irregular tubule*, then convoluted, called the

Distal convoluted tubule[10], [11], which terminates in a narrow *Curved* or *junctional tubule*[12], and finally joins the *Straight collecting tubule*[13], [14], terminating on the summit of one of the papillæ.

Describe these straight tubules[13], [14].

Traced into the pyramids from the papillæ, they run from the apex to the base, dividing dichotomously, receiving the curved tubules, to enter the cortex much increased in number, where they form conical masses, called the *pyramids of Ferrein*, with their bases toward the medullary portion.

Describe the epithelium of the uriniferous tubules.

It varies in different portions, being flattened, polyhedral, angular, striated, and columnar.

Describe the Malpighian tufts, or vascular glomeruli.

Each is formed by a *renal afferent*[a] (Fig. 128) *arteriole*, which, after piercing the capsule—a pouch-like commencement of a tubulus uriniferus lined with flattened epithelium[b]—breaks up into a tuft of vessels forming a plexus, from which arises the *efferent*[c] *vessel* or *vein*. These vessels are opposite the neck of the tubule, emerging from the capsule near the point of entrance of the afferent arteriole. The Malpighian tuft or glomerulus, surrounded by the capsule of Bowman, forms the two parts of the *Malpighian body* or *corpuscle*.

Describe the renal circulation.

Renal artery, from the aorta, gives small branches to the suprarenal capsule, ureter, and surrounding tissue; two renal arteries on one side are frequent; it divides just external to the hilum into four or five *primary branches*, which subdivide to form the

Arteriæ propriæ renales, lying in the columns of Bertin; two of these run along the sides of each Malpighian pyramid, giving off afferent branches to the Malpighian tufts, and, bending between the bases of the pyramids and cortex, send off the (1) *interlobular branches* and (2) *arteriolæ rectæ:*

(1) *Interlobular arteries*, passing outward between the pyramids of Ferrein to the capsule, terminating in stellate plexuses beneath it (*stars of Verheyen*), and also supplying afferent arterioles to the Malpighian tufts of the cortex, whence issue efferent vessels, forming a dense *venous plexus* around the adjacent uriniferous tubules;

(2) *Arteriolæ rectæ*, or *descending branches*, passing from the bases to the apices of the pyramids, there to terminate in the venous plexuses.

The blood is collected by the *stellate venous plexuses* beneath the capsule, forming *venæ interlobulares*, which pass between the pyramids of Ferrein, are joined by branches emptying the plexuses around the convoluted tubes of the cortex, and join the venæ rectæ at the bases of the Malpighian pyramids; these *venæ rectæ* being branches from *plexuses* at the apices of the medullary pyramids formed by the arteriolæ rectæ. The junction

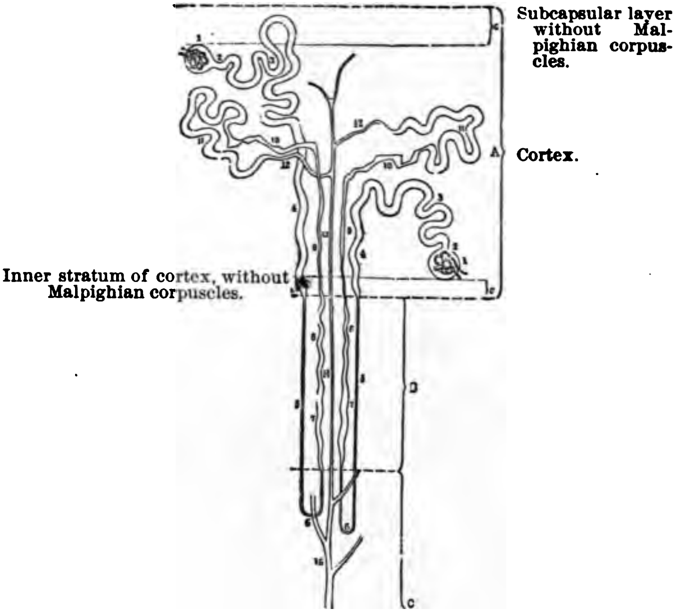

Subcapsular layer without Malpighian corpuscles.
Cortex.
Inner stratum of cortex, without Malpighian corpuscles.
A
D
C

FIG. 127—Uriniferous tubule (Leidy).

of the *venæ rectæ* and *venæ interlobulares* forms the *venæ propriæ renales*, accompanying the arteries of the same name, which receive venous twigs from the Malpighian tufts of the cortex and unite in the sinus to form the

Renal, or *emulgent vein*, which passes out of the hilum to empty into the inferior vena cava, the right vein being the shorter.

Describe the nerves of the kidney.

They are small, about fifteen in number, have ganglia developed upon them, and come from the solar plexus, lower and outer part of the semilunar ganglia, and from the lesser and smallest splanchnic nerves, forming the *renal plexus*, communicating with the spermatic plexus.

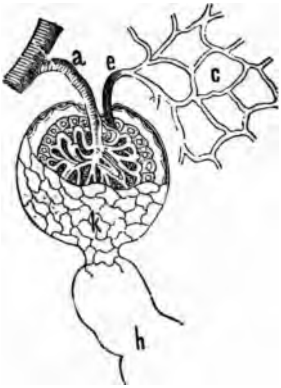


FIG. 128.—A Malpighian body or corpuscle (Leidy).

The Ureters.

What is the ureter?

It is the tubular, cylindrical, excretory duct of the kidney, of the size of a goose-quill, fourteen to sixteen inches long, extending from the sinus of the kidney to the base of the bladder, into which it opens by a constricted orifice, after having passed obliquely for nearly an inch between its muscular and mucous coats; it has a *fibrous coat* continuous with the capsule of the kidney and fibrous tissue of the bladder, a *muscular coat* composed of two longitudinal layers and a middle circular layer, a *mucous coat* covered with several layers of many-shaped epithelial cells, "transitional" epithelium.

Describe its course and relations.

It passes obliquely downward along the posterior abdominal wall beneath the peritoneum, over the iliac arteries, behind the ileum on the *right side*, and sigmoid flexure on the *left*, enters the posterior false ligament of the bladder in the male, with the vas deferens between it and the bladder, and enters the bladder obliquely about one and one-half inches behind the prostate, and two inches from its fellow; the internal openings are 20 mm. apart; in the female it passes along the upper part of the vagina and the side of the cervix uteri, being about three-fifths of an inch distant from the latter; the right ureter lies close to the outer side of the inferior vena cava.

The Bladder.

What is the bladder?

The musculo-membranous reservoir for the urine, situated between the os pubis and rectum in the male, or between the os pubis, cervix uteri, and part of the vagina in the female; moderately distended its dimensions are from above downward and backward 14 cm.; breadth, 12 cm.; antero-posterior diameter, 10 cm.; capacity, about one pint; in the child it is an abdominal organ and conical; in the adult, when empty, it may be Y-shaped, when distended, ovoid. The bladder has a *summit* and *five surfaces*, *superior*, *postero-inferior* or *base*, *antero-inferior* or *pubic*, and two *lateral surfaces* or *sides*.

Summit[10] (Fig. 131) is connected with the umbilicus by a fibro-muscular cord, the *urachus*, and by two fibrous cords, one placed on each side, the obliterated fetal hypogastric arteries; the *antero-inferior surface* lies against the posterior surface of the pubes, triangular ligament, internal obturator muscles, and—when distended—abdominal walls; the *superior surface*, being covered by peritoneum, has some coils of small intestine interposed between it and the rectum and uterus in the female; the obliterated hypogastric arteries cross its *sides* obliquely from below, upward and forward, all below them being uncovered with peritoneum; the vas deferens curves from before backward along each side to reach the base of the bladder passing across the obliterated hypogastric vessels and along the inner side of the ureter; the

Fundus or *base* (Figs. 129 and 131[11]) is directed downward and backward, resting in the male upon the second portion of the rectum, in the female upon the lower part of the cervix uteri, being adherent to the upper part of the vagina, but separated from the cervix by a fold of peritoneum which is reflected so as to cover a small portion of its base; in the male the peritoneum passes from the rectum to the same portion of the base.

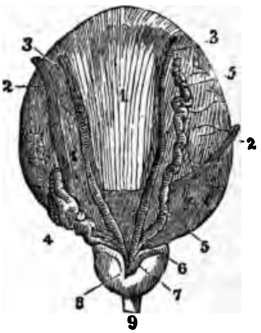


Fig. 129.—Posterior surface of the bladder; vasa deferentia and vesiculæ seminales (Leidy).

The bladder has no proper *neck* or *cervix.*

How is the bladder held in place?

By five *true* and five *false ligaments;* the true, being made of fascia, are

Anterior, or *pubo-prostatic*, formed by two folds of the recto-vesical fascia extending from either side of the pubic symphysis to the pubic surface of the bladder over the upper surface of the prostate gland;

Lateral, of the same tissue, passing between the lateral surfaces of the prostate gland and sides of the base of the bladder to the pelvic wall;

Urachus[22] (Fig. 131), a fibro-muscular cord covered with peritoneum, stretching from a point 4 to 20 mm. anterior to the apex of the bladder to the umbilicus.

The false ligaments are:

Two posterior, folds of peritoneum passing, in the male from the sides of the rectum, in the female from the sides of the uterus, to the postero-lateral aspect of the bladder, and contain the obliterated hypogastric arteries, the ureters, vessels, and nerves.

Two lateral, peritoneal folds passing from the iliac fossæ to the sides of the bladder.

Superior[23] (Fig. 131), a peritoneal fold passing over the urachus, *plica urachi*, from near the apex of the bladder to the umbilicus.

What is the urachus[22] (Fig. 131)?

The remains of a tubular canal connecting the bladder with the allantois; it has a stalk and may enclose a hollow space.

Describe the structure of the bladder.

It has four coats, viz. a

Peritoneal[23], [24] (Fig. 131), covering the superior surface from the entrance of the ureters at the base to its summit, passing on to the sides, whence it is reflected to the abdominal and pelvic walls: a

Muscular, consisting of fibers spirally arranged, forming figure-of-eight loops, the more superficial being nearly *longitudinal*, the deeper nearly *circular*, and finally a thin *internal longitudinal layer;* these form several more or less distinctly marked layers, the loops directed toward, and embracing the urachus and urethra respectively, the aggregation of these loops around the beginning of the urethra forming the *sphincter vesicæ;* the fibers passing in all directions are continued into the prostatic urethra (Pettigrew): the

Submucous coat is a layer of areolar tissue intimately blended with mucous membranes binding it to the muscular coat; a

Mucous coat, covered by transitional epithelium, the superficial layer of polyhedral cells, below club-shaped and smaller spindle-celled; it contains a few mucous follicles and numerous racemose glands lined with columnar epithelium near the neck; it is thrown into folds or *rugæ* when the bladder is empty.

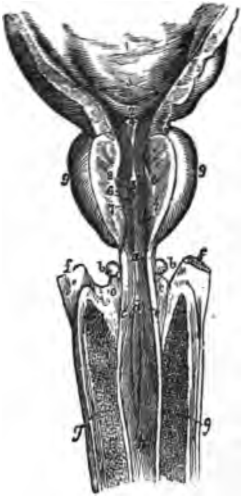


FIG. 130.—The bladder and urethra laid open (Leidy).

What are the muscles of the ureters?

Two oblique bands rising behind the orifices of the ureters which converge, to be inserted by a fibrous process into the middle lobe of the prostate gland.

What is the trigonum vesicæ or trigone vesical[2] (Fig. 130)?

A triangular smooth surface at the base of the bladder, with apex forward, of a paler color than the remainder of the mucous membrane, which is intimately adherent to the subjacent tissue: the

Lateral boundaries are two slightly marked ridges on each side passing backward and outward from the apex, formed by the urethral opening, to the orifices of the ureters[3], corresponding to the muscles of these ducts, the openings being placed one and one-half inches apart (some say 20 mm.) and one and one-half inches behind the urethral opening; a line of mucous membrane connecting the two forms the *base of the trigone*, called the *plica ureterica.*

What is the uvula vesicæ[4] (Fig. 130)?

A slight elevation of the mucous membrane projecting from the lower anterior portion of the floor of the bladder into the orifice of the urethra.

Mention the vessels connected with the bladder.

Superior, middle, and inferior vesical, and small twigs from the *obturator and sciatic arteries* in the male, with additional branches from the *uterine and vaginal* in the female; the *veins* form intricate plexuses around the neck, sides, and base, emptying into the internal iliac vein; the *lymphatics* accompany the vessels.

Give the nerve-supply of the bladder.

It is bilateral, coming from the hypogastric plexus of the sympathetic and third and fourth sacral nerves, sometimes the second sacral nerve.

The Male Urethra.

Describe this canal.

It extends from the neck of the bladder[4] to the meatus urinarius, measuring eight to nine inches (20.4 cm.), presenting a double curve if the penis is flaccid, but a single one with the convexity downward during erection.

Name and describe each of its divisions.

They are the prostatic[7], [8], membranous, and spongy.

The *prostatic portion*[7], [8] (Fig. 130), that portion passing from the base to the apex of the prostate gland, running nearer the upper surface, measuring one and a quarter inches long, is the widest and most dilatable section of the urethra and is spindle-shaped; upon the median aspect of the floor is a narrow longitudinal ridge eight or nine lines long, three-quarters of an inch, the *verumontanum* or *caput gallinaginis* [5], containing muscular and erectile tissue; on either side is a slight fossa, called the *prostatic sinus*, its floor presenting the openings of the lateral prostatic ducts; the ducts of the middle lobe open above the *verumontanum.*

The *sinus pocularis*, or *uterus masculinus* [6], is a depression extending about a quarter of an inch upward and backward beneath the middle lobe of the prostate in the median line at the forepart of the verumontanum, upon or within whose margins are the slit-like orifices of the *seminal* or *ejaculatory ducts* [6].

The *membranous portion* [a] is that portion, three-quarters of an inch long, extending between the apex of the prostate and bulb of the corpus spongiosum, which is included between the layers of the triangular ligament about one inch beneath the pubic arch; it is surrounded by the compressor urethræ muscle, and is the narrowest portion of the urethra, except the meatus.

The *spongy portion* [d], [h], the longest, measuring about six inches, is so called from being contained in the corpus spongiosum; it extends from the membranous portion to the meatus urinarius, and presents a posterior dilatation, that of the bulb [8] (Fig. 131), and one anterior, the *fossa navicularis* [16] (Fig. 131), the former having opening into it the ducts of Cowper's glands, the latter fossa being situated within the glans penis, having an

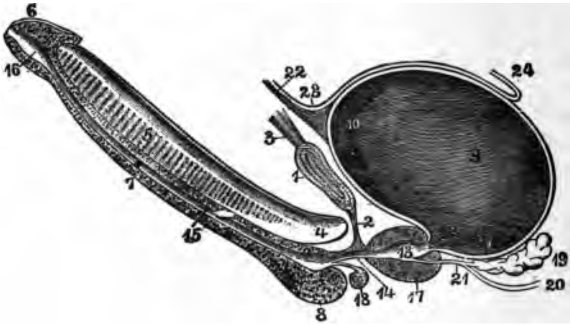


FIG. 131.—A vertical section of the bladder, penis, and urethra (Leidy).

opening directed forward in its roof, *lacuna magna*, the orifice of a large mucous crypt; there are also here numerous other scattered openings of glands and follicles similarly directed, *glands of Littré.*

What is the meatus urinarius?

The anterior orifice of the urethra, a vertical slit about three lines long, bounded on each side by a small labium; it is the narrowest portion of the canal.

Describe the structure of the urethra.

It possesses four coats, viz. a *mucous*, forming a part of the genito-urinary membrane internally and continuous with the skin externally, having numerous mucous glands imbedded in its submucous tissue, which open on its free surface; it is covered with columnar epithelium except near the meatus, where it is squamous.

The *submucous coat* is a thin layer of vascular erectile tissue, surrounding especially the prostatic and membranous portions.

External to this is the *muscular coat* (muscularis mucosæ); in the prostatic portion it consists of an inner longitudinal and an outer circular layer of unstriated muscle-fibers; they are directly continuous with the muscle-layers of the bladder. Both layers are present in the membranous portion and aid the sphincteric action of the striated urethral muscles. Both layers gradually cease in the spongy portion, the circular layer disappearing first; a few oblique and longitudinal fibers remain in the anterior part of this portion.

A variable *fibrous tunic* surrounds the muscular layer, giving support and strength to the canal.

The Female Urethra.

Describe this canal.

It is about one and one-half inches long, extends from the bladder to the meatus urinarius above the anterior vaginal wall, pierces the triangular ligament, and is embraced by the compressor urethræ muscle as in the male; its structure is similar to that of the male urethra; it is lined with laminated squamous epithelium merging into spheroidal near the bladder; it is a quarter of an inch in diameter, but is capable of much greater dilatation; the anterior opening (meatus) is situated near the anterior margin of the vagina, about one inch behind the clitoris, surrounded by a prominence of mucous membrane.

THE MALE GENERATIVE ORGANS.

Where is the prostate gland situated (Fig. 130)?

It surrounds the neck of the bladder and commencement of the urethra, lying in the pelvic cavity posterior to the deep perineal fascia, behind and below the symphysis pubis upon the rectum; through it pass the urethra and ejaculatory ducts.

Describe its form and size.

It resembles a horse-chestnut in form, measures one and a half inches transversely, one inch antero-posteriorly, three-quarters of an inch in depth, and weighs four and a half to four and three-quarters drachms; the base is directed backward toward the bladder; it consists of two equal-sized lateral lobes and a middle lobe, which is a small band or rounded triangular eminence placed between the lateral lobes immediately in front of the base of the bladder and below the commencement of the urethra.

Describe its structure.

It is composed of numerous follicular pouched glands opening into elongated canals which join to form twelve to twenty excretory ducts imbedded in the interstices of a stroma formed of interlacing bundles of unstriped muscle, the whole being inclosed in a fibrous capsule. Muscular tissue predominates over the glandular.

What retains the gland in place?

The pubo-prostatic ligaments, posterior layer of the deep perineal fascia, and anterior portions of the levator ani muscles.

Describe the situation and structure of Cowper's glands.

They are two small lobulated glands of the size of peas, lying between the two layers of the deep perineal fascia in front, close behind the bulb of the urethra, surrounded by the compressor urethræ muscle, and opening by ducts one inch long which pass obliquely forward beneath the mucous membrane, on the floor of the bulbous portion of the urethra.

The Penis.

Describe the penis.

It has a root, body[5] (Fig. 131), and extremity or glans penis[6], and consists of three elongated cylindrical masses of erectile tissue, composed of a fibrous sheath which sends inward numerous interlacing bands (trabeculæ), forming numerous meshes in which lie the blood-vessels. The upper two cylindrical bodies lying side by side, like a double-barrelled gun, are called the corpora cavernosa[5]; the third, much smaller, lying in the median line beneath, like the ramrod of a gun, is the corpus spongiosum.[7]

Describe the corpora cavernosa.

Situated as just described, they are intimately connected in their anterior three-fourths, where they are in contact, presenting a median dorsal groove for vessels and nerves, and an inferior median groove for the corpus spongiosum, while their posterior fourths diverge, forming the *crura*[4], which are attached to the rami of the pubes and to the ischia anterior to the tuberosities; near their point of junction with one another they become slightly enlarged, forming on either side the *bulb of the corpus cavernosum.*

What other structure secures the root of the penis?

The *suspensory ligament*, a band of fibro-elastic tissue, connected with the symphysis pubis and superficial fascia, which runs to the dorsum of the penis.

What is the septum pectiniforme[5]?

It is the anterior portion of the vertical septum between the corpora cavernosa which is incomplete, the fibrous bands resembling the teeth of a comb; the septum and fibrous sheath contain numerous elastic and muscular fibers in addition to the white fibrous tissue.

Describe the corpus spongiosum.

It incloses the urethra[15], lying medianly below at the junction of the corpora cavernosa, commencing behind in front of the deep perineal fascia between the crura of the corpora cavernosa as a rounded enlargement, the *bulb*[8], which is surrounded by the accelerator urinæ muscle. Anteriorly it forms a conical enlargement, flattening from above downward, which caps the blunted end formed by the corpora cavernosa, the *glans penis*[6], the margin of whose base is called the *corona glandis*, and the constriction behind, the *cervix.*

What other parts of importance does the penis present?

The *meatus urinarius*, the external orifice of the urethra, is a vertical opening at the summit of the glans penis.

The *prepuce*, a portion of the skin of the penis prolonged forward so as either completely or partially to cover the glans penis, lined with modified skin which covers the glans and joins the mucous membrane at the meatus.

Frenum preputii, a median fold of integument passing from behind the meatus at the bottom of a depressed raphé to become continuous with the under margin of the penis.

Glandulæ Tysonii odoriferæ, numerous small lenticular sebaceous glands upon the corona and cervix of the glans, secreting sebaceous matter with a peculiar odor.

What is meant by erectile tissue?

An intricate venous plexus formed by the interspace between the fibrous trabeculæ, the blood being delivered in the following ways: (1) by arteries terminating in ordinary capillaries—this is the arrangement in the corpus spongiosum and glans; (2) by fine convoluted arterial twigs opening directly into the venous network by funnel-shaped extremities.

What are the helicine arteries?

Convoluted, tendril-like arterial branches opening directly into the intertrabecular spaces, as just explained, most abundant in the back parts of the spongy and cavernous bodies.

Name the vessels, lymphatics, and nerves of the penis.

The arteries are all branches of the internal pudic, viz.

Artery of the bulb, on each side, to the corpus spongiosum.

Arteries of the corpora cavernosa, to these bodies.

Dorsal arteries of the penis, to the corpora cavernosa, glans, prepuce, and skin. The *veins* return the blood by the dorsal vein, prostatic and pudic venous plexuses; also by the pudic and obturator veins.

The superficial *lymphatics* end in the inguinal glands, the deep join the deep pelvic lymphatics.

The *nerves* are branches of the internal pudic and hypogastric plexus of the sympathetic.

The Testes and their Coverings.

What are the testes or testicles (Fig. 132)?

They are the procreating glands, those which secrete the spermatozoa, are of ovoid form compressed laterally, and are each obliquely suspended in the scrotum by the spermatic cord. They measure in length one and a half inches (37 mm.), one inch in breadth (24 mm.), and one and a quarter inches antero-posteriorly (28 mm.), weighing from six to eight drachms, the left being slightly the larger.

What is the scrotum?

A cutaneous pouch containing the testicles and part of the spermatic cords, formed of integument externally and beneath this of a reddish contractile layer, the *dartos*, continuous with the contiguous superficial fascia and sending inward a partition, the *septum scroti*, dividing the scrotum into two compartments.

Describe the coats of the testis.

They are, the *tunica vaginalis*, a serous coat originally derived from the peritoneum, consisting of a portion investing the testis and epididymis, the visceral layer, or *tunica vaginalis propria*, and a parietal layer, or *tunica vaginalis reflexa;* the

Tunica albuginea is formed of white fibrous tissue surrounding the gland and reflected into its interior at its postero-superior border to form an incomplete vertical partition, the *mediastinum testis*, or *corpus Highmori*, from which fibrous septa pass, *trabeculæ*, separating the glandular lobules; the

Tunica vasculosa, or *pia mater testis*, consists of a plexus of blood-vessels bound together by areolar tissue, which invests the *inner surface* of the tunica albuginea and sends off processes between the lobules.

What is meant by the coverings of the testis?

The structures with which the testes become invested in their passage, previous to birth, from the abdomen along the inguinal canals into the scrotum.

Name these coverings.

Skin, } scrotum, closely adhering to each other.
Dartos, }

Intercolumnar, or *external spermatic fascia,* derived from the margins of the external abdominal ring.

Cremaster muscle and fascia, derived from the lower border of the internal oblique muscle (some authors deny this).

Infundibuliform, or *fascia propria,* a downward continuation of the infundibuliform process of the transversalis fascia.

Subperitoneal areolar tissue comes next, then the *tunica vaginalis,* derived from the peritoneum.

Describe the structure of the testis.

It consists of some eight hundred to nine hundred *seminiferous tubules,* one-two-hundredths to one-one-hundred and fiftieth of an inch in diameter, convoluted so as to form three hundred conical *lobules,* with apices toward the mediastinum; the tubes then unite to form twenty or thirty larger ducts, one-one-fiftieth of an inch in diameter, called the *vasa recta*[c], which, passing upward and into the mediastinum, form a close network of anastomosing tubules, the *rete testis;* these at the upper end of the mediastinum terminate in twelve to twenty *vasa efferentia*[e], perforate the tunica albuginea, and become enlarged and convoluted, forming *coni vasculosi*[f], which aggregated compose the globus major of the epididymis; the *tubules* consist of a membrana propria lined with a layer of polyhedral cells, with two or more inner layers of spheroidal cells, which divide into epithelial cells ultimately to become converted into spermatozoa; the vasa recta and tubes of the rete testis have thin walls lined with one layer of squamous cells; the vasa efferentia and epididymis have thicker walls, containing muscular tissue, and are lined with columnar epithelium.

What is the epididymis?

A convoluted tube, some twenty feet long, lying along the posterior border of the testis, commencing on the testicle side by a convergence of the tubes of the *coni vasculosi*, and ending in the single vas deferens beyond.

Describe its various parts.

The *globus major*[e] is formed by the coni vasculosi, or *efferent ducts*, which open at intervals into the single duct forming the epididymis; the

Body[g] is the central portion, formed by the convolutions of the tube bound together by delicate areolar tissue; the

Globus minor[g] is the lower enlarged portion, composed as the body is, and connected to the testis by fibrous bands and areolar tissue; the

Vas aberrans is a narrow tube, occasionally extending up into the cord for two or three inches, and ending in a blind extremity, connected with the lower part of the tube of the epididymis, or commencement of the vas deferens; the

Hydatids of Morgagni are small bodies attached to the globus major or upper portion of the testicle by pedicles; they are probably the remains of the *duct of Müller;* one is very constant.

Describe the vas deferens[h].

It is the excretory duct of the testis, and is a continuation of the epididymis, commencing at the globus minor[g] to ascend along the posterior side of the testis and epididymis, back of the spermatic cord, through the inguinal canal to the internal abdominal ring, whence, passing into the pelvis, it crosses the external iliac, curves around the epigastric artery to reach the side, then by a curve downward and backward, the base of the bladder internal to the ureter[2] (Fig. 129); here it lies between the bladder and the rectum, coursing along the inner border of the seminal vesicle[5], becoming enlarged and sacculated, the ampulla, but narrowing at the base of the prostate, where, joined by the duct of the vesicula seminalis[6], it forms the ejaculatory duct[7]. It is one foot long, or two if unravelled, is about one and a quarter lines in diameter, its lumen but one-third line (0.7 mm.); it has thick, rigid walls, presenting a hard, cord-like sensation when rubbed between the fingers.

What are the vessels of the testis and its coverings?

The gland itself is supplied by the *spermatic artery*[m] (Fig.

132), the coverings receive blood from the *superficial external pudic* and the *deep external pudic* from the femoral, *superficial perineal* from the internal pudic, *cremasteric* from the epigastric, and *artery of the vas deferens* from the superior vesical.

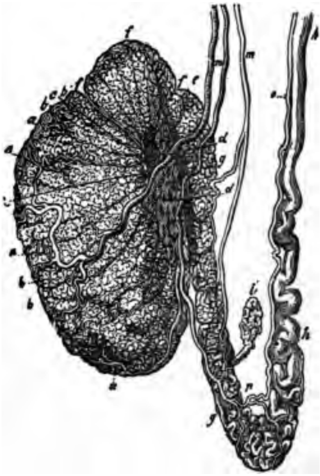


FIG. 132.—Vertical section of the testicle (Leidy).

The *veins* leave the back of the testicle, forming the *pampiniform plexus*, which ends in a single trunk emptying on the right side into the inferior vena cava, on the left into the left renal vein.

Veins of the same name as the arteries supplying the coverings, return blood to the femoral, external, and internal iliac veins.

What nerves go to each testicle and its coverings?

Branches from the spermatic plexus of the sympathetic to the testicle itself, to the coverings and cord the *ilio-inguinal*, *ilio-hypogastric*, *two superficial perineal*, *inferior pudendal*, and *genital branch of the genito-crural nerve.*

What are the component parts of the spermatic cord?

Vas deferens,
Spermatic artery,
Cremasteric artery,
Artery of the vas deferens,
Spermatic veins,
Areolar tissue,
Spermatic nerve-plexus,
Branch of the ilio-inguinal nerve,
Branch of the genito-crural nerve,
Vas aberrans (inconstant),
Lymphatics,
Remains of the peritoneal pouch.

These form a cord bound together by connective tissue, invested by fasciæ brought down by the testicle, about four inches long, extending from the globus minor to the internal abdominal ring.

Describe the vesiculæ seminales.

They are two lobulated membranous receptacles for the semen, which they dilute with their own secretion. They are pyramidal in form, are about two inches (50 mm.) long by five lines broad, by two to three lines thick, and lie in contact with the base of the bladder, diverging from each other from the base of the prostate to near the entrance of the ureters; they join by their anterior pointed extremities with the vas deferens, forming on each side the *ejaculatory duct*[7] (Fig. 129), terminating in the prostatic urethra by a slit-like orifice on each side, just upon or within the margin of the *sinus pocularis*[5] (Fig. 130) at the front of the verumontanum.

Describe the descent of the testes.

During early fetal life the testes lie at the back part of the abdomen, behind the peritoneum, just below and in front of the kidneys; attached to the lower end of the epididymis, and attaining its full development from the fifth to the sixth fetal month, is the *gubernaculum testis*, which contains muscular tissue; this divides below into three portions, passing to Poupart's ligament, to the os pubis and rectus muscle, and to the dartos at the bottom of the scrotum; the gubernaculum is supposed to contract and so cause descent of the testicle, but this is a moot point. Between the fifth and sixth months each testis reaches the iliac fossa, by the seventh it enters the internal abdominal ring, by the eighth month it has reached the scrotum, invaginating from behind the preformed peritoneal sac, *processus vaginalis*, the upper part of which usually becomes obliterated just before birth, the lower portion then forming the *tunica vaginalis testis* completely cut off from the abdominal cavity; the other structures in front of the testis are likewise carried onward, forming its covering, as already described.

THE FEMALE ORGANS OF GENERATION.

What is the vulva (Fig. 133)?

The term includes the following organs:

Labia minora[13],	*Vaginal orifice*[15],
Mons Veneris[4],	*Clitoris*[6],
Labia majora[5],	*Meatus urinarius*[14].

These parts are also called the *pudendum* and *external organs of generation.*

Describe the mons Veneris^{4}.

It is a rounded eminence surmounting the vulva in front of the symphysis pubis, formed by a collection of fatty tissue, and at puberty becomes covered with hair.

Describe the labia majora^{5} and minora^{13}.

The *labia majora*^{5} are two prominent longitudinal cutaneous folds passing downward from the mons Veneris to the anterior part of the perineum, enclosing the common *urogenital space.* Each labium is formed externally of hair-covered skin, internally of skin, enclosing between these *layers* fatty areolar tissue and a structure resembling the dartos of the scrotum, to which they correspond; the junction of the labia in front constitutes the *anterior commissure;* the *posterior commissure* is a fold of skin.

The *labia minora*, or *nymphæ*^{13}, are two thin cutaneous folds containing numerous sebaceous glands, inside the labia majora, running from the clitoris^{6}—where they form a hood-like prepuce and frenum—obliquely downward for about one and a half inches on each side of the vaginal orifice, to be lost in the labia majora.

Describe the remaining structures forming the vulva.

The *clitoris*^{6} is a small penis with root, body, and glans, composed of two corpora cavernosa formed of erectile tissue attached to the rami of the pubes and ischium by two crura^{7}; it has a suspensory ligament and two erectores clitoridis muscles.

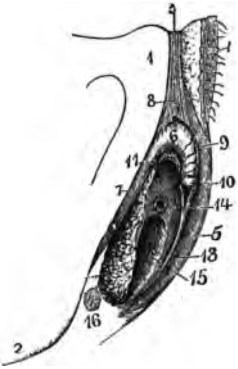


FIG. 133.—The vulva, or external generative organs (Leidy).

The *vestibule* is the triangular smooth surface below the clitoris, bounded on each side by the labia minora.

The *meatus urinarius*^{14} is placed at the back part of the vestibule, about one inch below the clitoris, near the vaginal margin, surrounded by a prominence of mucous membrane.

The *vaginal orifice*^{15} is of an elliptical form, usually more or less closed in the virgin by the hymen, and is surrounded by the sphincter vaginæ muscle, the analogue of the male accelerator urinæ muscle.

The *hymen* is a thin fold of mucous membrane, variously shaped, but usually that of a ring broadest behind, or semilunar, with its concavity upward, stretched across the lower part of the vaginal orifice; it may occasionally form a complete occluding membrane, the condition being then known as *imperforate hymen;* it may be practically absent in the virgin, and again may persist after copulation, but at that time is usually ruptured; after parturition it gives rise to small, rounded elevations surrounding the vaginal outlet, called *carunculæ myrtiformes.*

The *glands of Bartholin*[16] are small, oblong, reddish-yellow bodies, lying on each side of the commencement of the vagina, each opening by a long single duct external to the hymen on the inner side of each labium majus; they correspond to Cowper's glands in the male.

The *bulbi vestibuli*[12] are two oblong masses—a venous plexus enclosed in a fibrous envelope—extending from the clitoris along each side of the vestibule, a little behind the labia majora.

The *pars intermedia*[11] is another small venous plexus immediately in front of the preceding, with which it is continuous as well as with the glans clitoridis; these plexuses correspond to the corpus spongiosum.

The *fourchette* is a small transverse cutaneous fold, just within the posterior commissure; it is the junction of the labia minora.

The *fossa navicularis* is the space between the fourchette and the hymen; it is generally artificial, not normal.

The Vagina.

Describe it.

It is a cylindrical membranous canal flattened from before backward, lying between the rectum and the bladder, extending from the vulva to the uterus, curved backward and upward, conforming to the axis of the pelvis and of the outlet. Narrow at its orifice, it is larger above, its anterior wall measuring about two and a half inches, its posterior three and a half, being attached higher up on the cervix uteri *behind* than in *front.*

Describe its structure.

It is formed of an external layer of fibrous tissue, a muscular coat, and a lining mucous membrane with a *median anterior* and a *posterior raphé* or *columns of the vagina*, which give off transverse rugæ; mucous glands are absent; the epithelium is squamous.

Give the relations of the vagina.

Its *anterior surface* is in relation with the base of the bladder and urethra; the *posterior surface* is in relation with the rectum, its lower four-fifths being separated from it by the perineum and connective tissue, its upper fifth by a recto-uterine fold of peritoneum, forming *Douglas's cul-de-sac* or *pouch.*

Laterally, above it gives attachment to the broad ligaments of the uterus, below to the levatores ani muscles and recto-vesical fascia.

The Uterus and its Appendages.

Describe the position and parts of the uterus (Fig. 134).

It is the organ of gestation, situated in the pelvic cavity between the rectum and bladder, opening below into the vagina, which is attached around its cervix. It is pear-shaped, flattened from before backward, is about three inches long, two inches in breadth at the upper part, and one inch thick, weighing from one to one and a half ounces (33 to 41 gm.); it presents for examination the

Fundus[2], which is convex, covered with peritoneum, and placed below the level of the brim of the pelvis; the

Body gradually narrows from the fundus to the neck, with the anterior flattened surface covered with peritoneum as far as the internal os, and a posterior peritoneum-covered convex surface, while each lateral margin is concave, affording attachment to the Fallopian[9] tube above, to the round ligament in front and below this, and to the ovarian ligament below and behind both; the

Cervix[3] is the lower, rounded, constricted portion of the uterus, which lies partly above the vagina and partly within it; it consists of three zones, upper, lower, and middle; *supravaginal*, *intravaginal*, the *middle zone* affording attachment to the vaginal walls.

Cavity of the body is small, triangular, flattened from before backward, its upper extended lateral angles being funnel-shaped, at the apex of which each opens by a minute orifice into the Fallopian tube; at the inferior angle is the small opening into the cavity of the cervix called the *os internum* or *internal os uteri;* the

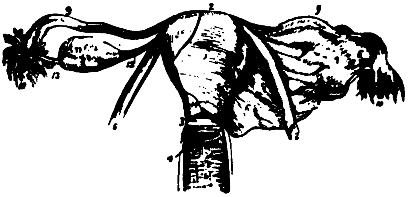


FIG. 134.—Anterior view of the internal generative organs (Leidy).

Cavity of the cervix is spindle-shaped, flattened antero-posteriorly, and opens into the cavity of the uterus above by the *internal os uteri*, and below into the vagina by the *external os uteri;* a median longitudinal crest of mucous membrane on the back and front walls, from which proceed obliquely upward other smaller ones, forms the *arbor vitæ uterina*, hardly noticeable after the first labor; the

Os externum or *external os uteri* (also os tincæ)[4] is a transversely ovoidal opening from the cervix into the vagina, which presents an *anterior* and a *posterior lip*, both in contact with the posterior vaginal wall.

Describe the ligaments of the uterus.

Six are peritoneal folds, viz.

Anterior or *vesico-uterine*, two crescentic folds passing between the uterine neck and the back of the bladder; the

Posterior or *recto-uterine* pass from the uterus and vagina to the sacrum and rectum; the peritoneal pouch thus formed between the rectum, the uterus, and the upper fifth of the vagina being called *Douglas's* or the *recto-uterine pouch;* the

Two lateral or *broad ligaments*[7] (Fig. 134), stretched between the sides of the uterus and the lateral walls of the pelvis, dividing this cavity into two portions, each containing between its folds the Fallopian tube[9], the round ligament[8], ovary and its ligament, parovarium, and connective tissue.

Describe the round ligaments of the uterus[8].

They are two muscular cords, four or five inches long, commencing at the superior angles of the uterus to pass forward and outward through the internal abdominal ring into the inguinal canal, to become lost in the labia majora and in the fatty tissue of the mons Veneris; they consist of dense fibrous tissue and unstriped muscle, enclosed, in the fetal state, by a process of the peritoneum extending a short distance into the inguinal canal, the so-called *canal of Nuck*, usually obliterated in the adult, but sometimes pervious throughout life; this corresponds to the processus vaginalis of the male.

Describe the structure of the uterus.

The womb has three coats, viz.

A *serous*, derived from the peritoneum, covering the fundus of the organ, its posterior surface, and posterior part of the cervix; also the whole of the anterior surface of the body to a point opposite the internal os.

A *muscular*, forming the bulk of the uterus, composed of bundles of unstriped muscular tissue interspersed with areolar tissue, blood-vessels, lymphatics, and nerves. The fibers are disposed in three layers, viz. external, in front of and behind the fundus; middle layers, passing longitudinally, obliquely, and transversely; and internal, arranged in two hollow cones whose apices surround the orifices of the Fallopian tubes, whose bases fuse in the middle of the uterine body; at the internal os these fibers are circular and sphincteric.

A *mucous*, thin, smooth, and closely adherent to the subjacent parts, covered with columnar ciliated epithelium, and containing numerous tubular follicles, most numerous in the cervix; when their ducts become obliterated their secretion is retained, forming small vesicular elevations within the os and cervix, called *ovula Nabothi*. The epithelium loses its cilia at the lower third of the cervix.

Name the uterine vessels and nerves.

The *arteries* are the *uterine*, from the internal iliac, and *ovarian*, from the aorta, which pursue a very tortuous course and freely anastomose.

The *veins* accompany the arteries and terminate in uterine plexuses; during pregnancy they are called *uterine sinuses*, consisting of the lining membrane of the vein adhering to the walls of canals channelled through the uterine substance; the *Lymphatics* terminate in the pelvic and lumbar glands; the *Nerves* are branches of the inferior hypogastric and spermatic plexuses, and of the third and fourth sacral nerves.

What are the Fallopian tubes?

They are the *oviducts*, two tubes four to five inches long, extending between the layers of the broad ligament on each side from the superior angle of the uterus, passing out for one inch to the side of the pelvis, then upward, backward, and downward to the inner surface of the ovary. Each has an *isthmus*, *ampulla*, *neck*, and *fimbriated extremity;* the *isthmus* is the inner constricted third of the tube, opening into the uterine cavity by a bristle-sized orifice; the *ampulla* is larger, tortuous, curves over the ovary, and includes one-half of the total length, passing from the isthmus to the *neck*. The ovarian end expands like a trumpet into the *infundibulum*, with its *ostium abdominale*[10] surrounded by fringe-like *fimbriæ*, hence the term *fimbriated extremity*[10]; one band is attached to the ovary, *ovarian fimbria*, and has a longitudinal groove. Their walls are formed of a serous or peritoneal coat, a muscular, formed of longitudinal and circular fibers, and a mucous coat covered with ciliated columnar epithelium, continuous on one side with the uterine mucous membrane, on the other with the peritoneum.

Describe the ovaries[11].

They are two flattened, ovoid bodies suspended by their anterior margins from the back of the broad ligaments[7], in loops of the Fallopian tubes; they have *mesial* and *lateral surfaces*, *posterior* and *anterior borders*, *upper* and *lower extremities* (His); they are attached by their lower extremities to the uterus, by the ovarian ligaments and by their upper ends to one of the fimbriæ of the Fallopian tube; their dimensions are: *length*, one and a half inches; *width*, three-fourths of an inch; *thickness*, one-half inch.

Describe the structure of the ovaries.

They consist of numerous *Graafian follicles* embedded in a fibrous stroma, *covered externally* by modified peritoneum, having columnar instead of squamous cells of a dull white appearance.

The *stroma* consists of numerous spindle-cells with connective tissue and abundant blood-vessels; a condensed peripheral layer under the epithelium was formerly described as the *tunica albuginea.* The stroma has elastic and muscular tissue.

What are the Graafian follicles?

Ovisacs, minute vesicles, 70,000 at birth, diameter from $\frac{1}{100}$ inch (0.25 mm.) to the size of a currant when ready to rupture; microscopically they are seen to consist of an *external fibro-vascular coat* connected with the stroma by a vascular network, and an internal coat, or *ovicapsule*, lined with a layer of nucleated cells, the *membrana granulosa*, which are heaped up around the ovum at that part of the *Graafian follicle* nearest the ovarian surface, forming the *discus proligerus;* the follicle contains also a transparent, albuminous fluid, *liquor folliculi*, supporting the ovum.

Describe the human ovum.

It is a spherical mass of protoplasm, $\frac{1}{125}$ inch (0.2 mm.) in diameter, just visible to the naked eye, and consists of the

Vitelline membrane, *zona pellucida*, or, best, *zona radiata*, as it possesses striæ thought to be pores; it surrounds the

Vitellus, or *yolk*, a fluid containing granules, protoplasm, deutoplasm, and a nucleus $\frac{1}{500}$ inch (0.05 mm.) in diameter; the nucleus is the

Germinal vesicle, containing a smaller body, or nucleolus, the

Germinal spot, $\frac{1}{3600}$ inch in diameter.

What is a corpus luteum?

An irregular yellow spot in the ovary at the site of a ruptured Graafian follicle, which differs in appearance according as it is a *true* or *false corpus luteum.*

Describe the differences between these two kinds.

The *true corpus luteum* is that of pregnancy; it is single and increases up to a certain point, at the fifth month occupying sometimes the greater part of the ovary, and usually does not entirely disappear until one or two months after delivery.

The *false corpus luteum* is that following ordinary menstruation; it is much smaller and disappears in about two months.

Name the ovarian arteries, veins, and nerves.

The *arteries* are the ovarian, from the aorta, anastomosing with the uterine artery; these vessels also supply the Fallopian tubes; the

Veins follow the arteries and form a plexus near the ovary, called the *pampiniform plexus.*

The *nerves* are derived from the inferior hypogastric or pelvic plexus, and from the ovarian plexus; the Fallopian tubes receive branches from the uterine nerves.

What is the parovarium?

It is also called the *organ of Rosenmüller;* it is the remains of a fetal structure, and in the adult consists of a few closed convoluted tubes lined with epithelium, one commonly ending in a bulbous hydatid-like swelling; at its tubal end the parovarium is connected with the remains of the Wolffian duct—the *duct of Gärtner.*

THE MAMMARY GLANDS.

Describe the mammæ.

They exist in both sexes, being in the male only rudimentary, but in the female are two large hemispherical eminences situated toward the lateral aspect of the pectoral region, reaching from the midaxillary line to the sternum, and from the second to the sixth or seventh ribs; just below the center at the fourth rib projects a conical prominence, the *nipple*, surrounded by a light-colored *areola*, in which are numerous prominent sebaceous glands, which enlarge during pregnancy; the color of both nipple and areola darkens during pregnancy, and the latter also extends its area.

Describe the structure of the mammary glands.

They are composed of gland-tissue, of fibrous tissue connecting the lobes, and fatty tissue in intervals between the lobes; the lobes consist of lobules formed of a number of rounded vesicles grouped about a small lactiferous tube into which their ducts open, and by their union finally form fifteen or twenty excretory ducts, or *tubuli lactiferi*, which converge toward the areola, dilating beneath it into the *ampullæ* at the base of the nipple, where they contract into straight tubes perforating the summit of the nipple; the lobules are surrounded by a dense capillary network during lactation, as is also the nipple, which becomes erected when irritated, partly from fulness of blood, partly from contraction of its muscular tissue.

Name the vessels and nerves of the mammæ.

The *arteries* are derived from the thoracic branches of the axillary, intercostal, and internal mammary arteries; the

Veins form an anastomotic circle around the base of the nipple, called the *circulus venosus*, from which large vessels radiate to terminate in the axillary and internal mammary veins; the

Lymphatics chiefly run along the lower border of the pectoralis major to the axillary glands, a few pass through the intercostal spaces to the anterior mediastinal glands; the

Nerves come from the anterior and lateral thoracic cutaneous.

THE ORGANS OF SENSE.

The Skin and its Appendages.

Of what parts does the skin consist?

1. *Epidermis*, or *cuticle*, formed of
    - (a) *Stratum corneum*,
    - (b) *Stratum lucidum*,
    - (c) *Stratum granulosum*,
    - (d) *Stratum mucosum*, or *rete Malpighii.*
2. *Derma*, *cutis vera*, or *corium*, formed of
    - (a) *Stratum papillare*,
    - (b) *Stratum reticulare.*
3. *Stratum subcutaneum.*

Enumerate the accessory structures contained in the skin.

The *tactile corpuscles*, in the papillæ of sensitive parts.

Ducts of the sebaceous and *sweat-glands*, *Hair-follicles*, passing through all the layers of the skin.

Nails, *hairs*, *sebaceous glands*, *sudoriferous* or *sweat-glands.*

Where do sweat- and sebaceous glands with the hair-follicles lie?

Chiefly in the subcutaneous fatty tissue, but sometimes in the deepest layers of the corium.

Describe the epidermis.

It is composed solely of epithelial cells, the deepest layer being columnar, more rounded in the middle portions, and flat, scaly, and horny on the free surface; the deepest, softest layer is accurately moulded upon the papillary layer of the derma, and contains the skin-pigment; it is called the *stratum mucosum.*

Describe the derma.

It is a tough, flexible, and highly elastic tissue, protecting subjacent parts, and is the chief organ of the sense of touch; excretion is effected by its various glands, and absorption also takes place from its surface. The derma consists of the

Papillary layer, situated upon its free surface, presenting innumerable, minute, vascular, conical eminences, averaging in length one one-hundredth of an inch by one two-hundred-and-fiftieth of an inch in diameter at their bases, scattered irregularly in slightly sensitive parts, but arranged in parallel curved lines, forming ridges, in highly sensitive regions; each papilla contains one or more capillary loops, and one or more nerve-fibers, some terminating in oval-shaped bodies, the *tactile corpuscles*, where touch is most highly developed; *Pacinian corpuscles* lie in the subcutaneous tissue.

Reticular layer contains interlacing bands of white fibrous tissue, with some yellow elastic fibers, unstriped muscular fibers wherever hair exists, lymphatics, blood-vessels, and nerve-plexuses.

What are the nails?

Flattened, horny structures of modified epithelium, covering the dorsal aspects of the derma of the distal phalanges of the fingers and toes. They are convex externally, and have a *root*, embedded in a groove of skin, whence comes the growth in length; a *matrix*, that portion of the derma beneath, by which the nail grows in thickness; the *lunula*, the white crescentic portion next to the root, its color due to diminution in size, number, and vascularity of the papillæ, which are disposed in longitudinal rows elsewhere in the matrix.

What are the hairs?

They are also modified epidermis, found everywhere in the skin, except the palms of the hands and the soles of the feet, but vary in size. Each has a *root* and *hair-bulb* on a *hair-papilla* in a *hair-follicle.*

The *root*, bulbous in form, springing from a vascular papilla at the bottom of an involution of the epidermis and corium, called a hair-follicle, which sometimes extends into the subcutaneous cellular tissue; into the hair-follicle open two to five sebaceous glands; hairs are raised by smooth muscle-fibers, *Mm. arrectores pilorum.*

The *shaft* consists of a *central pith* or *medulla*, a *fibrous portion* or *cortical substance*, and a *cuticle* of thin flattened scales; the medulla is commonly absent in fine hairs.

The *point* is formed only of the cuticle and cortical portions.

Describe the sebaceous glands.

Most abundant in the scalp, face, armpits, around the anal, nasal, and oral apertures, and in the external auditory canal; the largest are the Meibomian glands of the eyelids. They are small sacculated glands, lodged in the stratum papillare of the corium of nearly every part, except the palmar and plantar surfaces; the ducts usually open into the hair-follicles, but sometimes on the general surface of the skin.

Describe the sweat-glands (coil glands).

Each has a single *excretory duct* and *coil*, situated either in the deepest portion of the corium, or more usually in the subcutaneous cellular tissue, and opening on the free surface by a spiral duct between the papillæ; the tubes are formed of an external fibro-cellular coat, continuous with the superficial layer of the corium, and a lining of epithelial cells continuous with the epidermis. They are found mostly in the palms and soles.

What are their estimated number and area?

Nearly two and a half millions, forming an evaporating area of about eight square inches.

The Organs of Taste.

Where does the sense of taste reside?

In the mucous membrane of the dorsum and sides of the tongue, upper portion of the pharynx, soft palate, and fauces.

Are there any special taste-organs?

Certain *taste-buds*, flask-like bodies, are supposed to communicate with special nerves of taste; no such continuity has been positively demonstrated. The taste-buds consist of spindle-shaped, flattened *sustentacular cells* externally; the central *gustatory cells* have a bulging body and two processes, the inner may be continuous with a nerve-fibril, the outer passes to a *gustatory pore* on the mucous surface and ends in a cilium, *taste-hair;* these bodies are found in the circumvallate and fungiform papillæ, at the sides of the base of the tongue, anterior surface of the soft palate, posterior surface of the epiglottis, anterior surface of the anterior pillar of the fauces. *Special nerves of taste* are probably the *glossopharyngeal* by (1) lingual branches from the posterior third and by (2) the *chorda tympani*, which communicates with this pair from the anterior two-thirds.

The Organs of Smell.

Where does the sense of smell reside?

In the mucous membrane lining the upper portion of the nasal fossæ, where the *olfactory nerve-filaments* are distributed.

Describe the nasal mucous membrane.

It is also called the *Schneiderian* or *pituitary membrane*, and is continuous with that of the pharynx, Eustachian tube, tympanum, and mastoid cells, and with that of the accessory nasal cavities, the frontal, ethmoidal, and sphenoidal sinuses and antrum; also through the lachrymo-nasal duct with the conjunctiva. Its epithelium is squamous below in the *vestibule*, in the *respiratory region* ciliated and columnar, in the *olfactory* columnar; it contains numerous mucous glands; above, certain nucleated bodies are found, the *olfactory cells of Schultze*, with two processes, one running between the epithelial cells to the free surface, the other inward, to connect with a terminal nerve-fiber.

What vessels supply the exterior of the nose?

Lateralis nasi, from the facial to the alæ of the nose; the

Artery of the septum, from the superior coronary; the

Nasal branches of the ophthalmic and infraorbital to the dorsum and sides of the nose; the

Veins terminate in the facial and ophthalmic.

What are the vessels of the nasal fossæ?

Anterior and *posterior ethmoidal* from the ophthalmic to the ethmoidal cells, frontal sinuses, and roof; the

Spheno-palatine and a twig of the *small meningeal* from the internal maxillary to the membrane over the spongy bones, meatuses, and septum; the

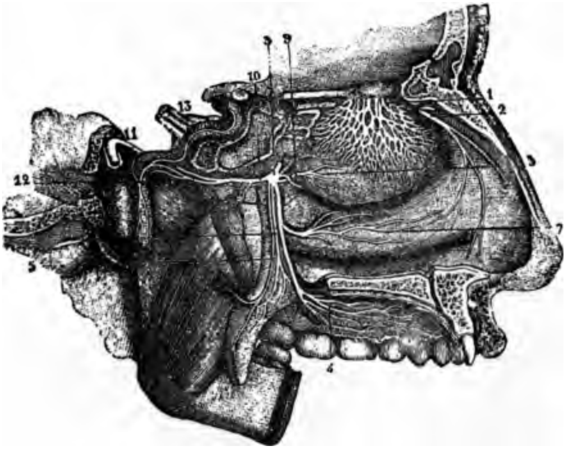


Fig. 135.—The spheno-palatine ganglion and its branches; the nerve-supply of the left nasal fossa (Leidy).

Alveolar from the internal maxillary to the antrum; the

Veins usually accompany the arteries, terminating in the facial and ophthalmic veins, and in the cranial sinuses.

What nerves supply the exterior of the nose?

Branches of the *facial*, *infraorbital*, *infratrochlear*, and *nasal branch* of the *ophthalmic*.

Describe the nerve-supply of the nasal fossæ (Fig. 135).

The *olfactory*[1] is distributed to the mucous membrane over the upper third of the septum and superior spongy bones; the

Nasal branch of the ophthalmic[2] supplies the upper anterior part of the septum and outer wall; then it emerges to the skin of the ala.

Anterior dental branch of the superior maxillary supplies the inferior turbinated bone and inferior meatus; the

Spheno-palatine ganglion[8], by the *naso-palatine* branch[7], supplies the middle of the septum; by the *anterior palatine*, the middle and inferior spongy bones.

The *Vidian*[10] supplies the upper back part of the septum and superior spongy bones, parts to which are also distributed the upper anterior nasal branches of the spheno-palatine ganglion[8].

(For the bones forming the nasal fossæ, see p. 66.)

The Eye.

Describe the eyeball.

It is a spherical organ, with the segment of a smaller transparent sphere, the cornea, forming its anterior portion, lying in the orbit in a cushion of fat, and held in position by the ocular muscles, the optic nerve, conjunctiva, and eyelids. The following points should be studied:

The eyeball is flattened from before backward, so its *transverse diameter* is the longest of the three; it measures almost one inch ($\frac{98}{100}$; 24.5 mm.); *antero-posterior diameter*, $\frac{96}{100}$ inch (24.0 mm.); *vertical diameter*, $\frac{94}{100}$ inch (23.5 mm.).

Anterior and *posterior poles*, the centers respectively of the cornea and the fundus oculi.

Axes of eyeballs, or ocular axes which pass through the poles of each eye and are nearly parallel, *not corresponding to the axes of the orbits*, which diverge.

Visual axis passes from the yellow spot through the center of the curvature of the refracting media, so that *these axes converge.*

Nodal point, the center of the curvature of the refracting media.

Equatorial plane, that passing through the center of the eyeball at right angles to the axis, dividing the globe into two segments, an anterior and a posterior hemisphere.

Equator, the line where the above-mentioned plane cuts the surface of the eyeball.

Meridional planes, planes coinciding with the ocular axis.

Meridians, the lines where the meridional planes cut the surface of the eyeball.

What is the capsule of Tenon?

The *tunica vaginalis oculi*, and consists of a thin membranous sac isolating the eyeball and allowing free movement, arising from the optic foramen behind to become lost upon the sclerotic and conjunctiva in front, having a visceral layer for two-thirds of the globe, a parietal layer lining the fatty cushion in which the eye rests, both layers being lined by flattened endothelial cells: the two layers enclose a lymph-space, *space of Tenon*, into which open the lymphatics of the sclerotic, lymph-space of the sheath of the optic nerve, and the perichoroidal space. The straight and oblique ocular muscles pierce it and receive sheaths from it; it is strengthened by elastic and fibrous bands. Below and in front of the inferior rectus a strengthening band of fibrous tissue runs from the lacrimal to the malar bone like a sling, *ligamentum suspensorium oculi.*

What are the tunics or coats of the eye (Fig. 136)?

The *sclerotic* and *cornea*, the most external, protective tunic.

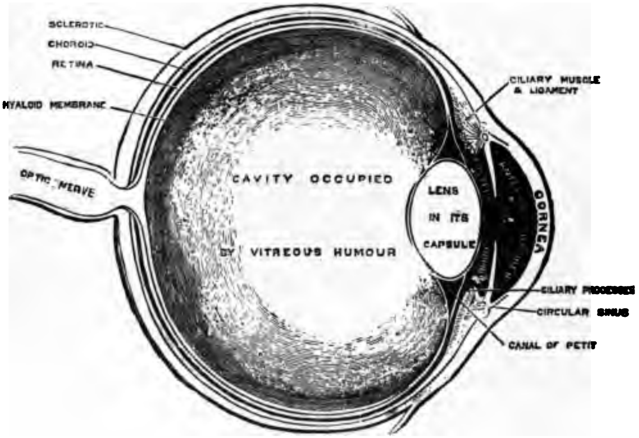


FIG. 136.—Section of the eyeball.

The *choroid*, *iris*, and *ciliary processes*, the middle or vascular tunic.

The *retina*, the innermost, nervous tunic.

What are the humors of the eye?

The refracting media are three in number, viz.

The *aqueous*, filling the anterior chamber;

The *crystalline*, or crystalline lens and capsule;

The *vitreous*, filling the posterior four-fifths of the globe.

Describe the sclerotic.

It is a firm, unyielding fibrous membrane, maintaining the form of the posterior five-sixths of the globe, thicker behind than in front, with a smooth white external surface except where tendons are attached, covered in front by the conjunctival membrane, and having an inner rough brown-stained surface, *lamina fusca.* Posteriorly and to the nasal side it is pierced by the optic nerve with whose sheath it is continuous, the sclerotic at this point forming a thin

Lamina cribrosa, through whose openings the nerve-filaments pass, the most central orifice, called the *porus opticus*, transmitting the arteria centralis retinæ. Surrounding the cribriform lamella are numerous small openings for the ciliary vessels and nerves; four venæ vorticosæ emerge from it, and the anterior ciliary vessels pierce it near the corneal border. The sclerotic is formed of white fibrous tissue, mingled with fine elastic fibers and fusiform nucleated cells. The following should be noted:

Thickness, $\frac{1}{25}$ inch posteriorly (1. mm.), $\frac{1}{60}$ inch anteriorly (0.4 mm.), about 6 mm. from the cornea.

Lamina fusca, the pigmented tissue connecting the sclerotic with the choroid by fine threads which traverse a lymph-space.

Subconjunctival tissue, loose areolar tissue binding the conjunctiva to the sclerotic; the

Arteries are few, coming from the *ciliary*, and forming a coarse network; the

Anterior vascular zone, surrounding the cornea, is formed by the subconjunctival branches of the anterior ciliary vessels; the existence of

Nerves is very doubtful.

Describe the cornea.

It is the transparent, projecting, anterior sixth of the external tunic. It is not quite circular, being a little broader in the transverse than in the vertical diameter, and is set in the sclerotic somewhat like a watch-crystal in its case; its thickness, one-thirty-second of an inch to one-twenty-second of an inch, is nearly the same throughout except toward the outer margin, where it is thinner; it is *non-vascular*, the capillary vessels ending in loops at its circumference; the *nerves* are numerous, from twenty-four to forty-five, and are derived from the ciliary and form the *subepithelial* and *intraepithelial plexuses.*

Describe the structure of the cornea.

It consists, from without inward, of the following five layers:

Layer of anterior epithelium, deepest cells columnar, next polyhedral, most superficial several layers of scaly cells; the

Anterior limiting membrane, membrane of Bowman, $\frac{1}{2500}$ inch (0.01 mm.) to $\frac{1}{1200}$ inch (0.02 mm.) thick, forming a thin, firm, elastic layer consisting of extremely closely interwoven fibrils similar to those of corneal tissue proper, but with no corneal corpuscles; it differs wholly from the posterior elastic lamina.

The *substance proper* is fibrous, tough, unyielding, continuous with the sclerotic and composed of sixty superimposed, flattened lamellæ made up of fibrillar connective tissue continuous with fibers of the sclerotic; the layers are held together by a cement-substance in which are *corneal spaces*, stellate in form, communicating with adjacent spaces by processes, each space containing a similarly shaped but smaller *corneal corpuscle* which does not entirely fill it; the

Posterior elastic lamina (*membrane of Descemet* or *Demours*) is a structureless, elastic, brittle, extremely thin membrane, not rendered opaque by water, alcohol, or acids; its chief peculiarity is the tendency to roll upon itself with the attached surface innermost, when separated from the cornea proper; at its circumference it breaks up into bundles of fibers forming the *ligamentum pectinatum iridis*, and leaving little intervals or spaces between the bundles; the

Posterior endothelial layer is a single layer of polygonal, transparent, nucleated cells, like those lining other serous cavities.

Describe the choroid (Fig. 137).

It is a thin, dark-brown, vascular membrane investing the posterior five-sixths of the globe, terminating in front at the ciliary muscle, there bending inward to form the ciliary processes; externally it is loosely connected by a non-vascular elastic layer, the *lamina suprachoroidea*, with the lamina fusca of the sclerotic; each has an endothelial coat, thus forming a lymph-space.

Choroid proper consists of two layers; the *external layer* is formed of the larger branches of the ciliary arteries and the venæ vorticosæ, interspersed with stellate pigment-cells, by the union of whose processes a delicate network is formed.

Internal layer, *tunica Ruyschiana*, or *choriocapillaris*, consists of a fine capillary plexus formed by the short ciliary vessels, which is separated from the pigmentary layers of the retina by the

Lamina vitrea, *membrane of Bruch*, a thin, glassy layer.

Between the two layers of the choroid proper is a thin *boundary zone* of fibers, *tapetum fibrosum*, producing a metallic luster.

The *arteries* of the choroid are the short, posterior, ciliary, and the recurrent branches from the long posterior and the anterior ciliary.

The *veins* form four or five *venæ vorticosæ* (Fig. 137), which pierce the sclerotic midway between the corneal margin and the entrance of the optic nerve.

The *nerves* are the long and short ciliary nerves.

What are the ciliary processes?

Sixty to eighty folds form a circle by the plaiting and folding of the choroid at its anterior margin, which are received between the corresponding folds of the suspensory ligament of the lens; they consist of large and small processes, irregularly alternating; the former are about one-tenth of an inch long. They contain *ciliary glands.*

What is the ciliary body?

It is that portion of the middle tunic between the choroid and the iris formed of the ciliary muscle and ciliary processes.

Describe the ciliary muscle[b].

A grayish triangular band of unstriped muscular fibers about one-eighth of an inch broad, thickest in front, thinnest behind, consisting of *radiating* and *circular* fibers, the former the more numerous, arising from near the sclero-corneal junction to pass backward to the choroid opposite the ciliary processes; the latter are internal, and pursue a circular course around the insertion of the iris; they are called the *circular ciliary muscle*, and were formerly described as the ciliary ligament.

Describe the circulus arteriosus major and minor.

The former is an anastomotic ring formed by the long ciliary arteries at the outer margin of the iris; the latter, a second anastomotic circle, is formed by transverse offsets from the converging branches passing forward to the pupil from the circulus major.

Describe the iris° (Fig. 137).

It is a thin, circular, perforated, contractile curtain, suspended behind the cornea in the aqueous humor in front of the crystalline lens, forming the anterior portion of the middle ocular tunic. It is formed of *radiating* and *circular muscular* fibers, and of a *fibrous stroma. Anteriorly* it is covered by a layer of polyhedral cells resting on a fine *basement-membrane,* being continuous with the membrane of Descemet; the *posterior surface* is pigmented epithelium.

Pupil, the nearly central opening in the iris placed a little to the nasal side of the center; diameter ranges from 1 mm. to 8 mm.

Ligamentum pectinatum iridis, a reticular tissue, connecting the iris with the cornea, derived from the membrane of Descemet, which sends fibrous prolongations to the iris and sclero-corneal junction.

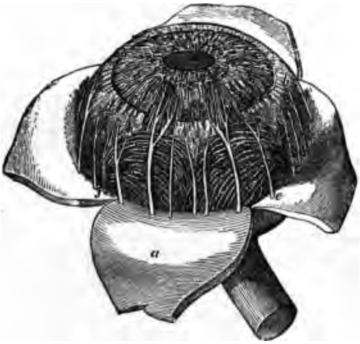


FIG. 137.—The choroid and iris.

Spaces of Fontana, the intervals between the reticulated fibers of the ligamentum pectinatum at the outer angle of the anterior chamber, which communicate with a larger space in the sclerotic close to the sclero-corneal junction and with the anterior chamber.

Canal of Schlemm, or *sinus circularis iridis,* lined with endothelium, a venous sinus, containing two or three plexiform veins receiving blood from the sclerotic and ciliary plexuses and communicating with the anterior ciliary veins.

Uvea, a layer of purplish-hued pigment-cells on the posterior surface of the iris continuous with the retinal pigment-layer of the ciliary processes.

Sphincter pupillæ, the narrow band of circular muscular fibers surrounding the pupil on its posterior surface, one-fiftieth of an inch wide (0.5 mm.), supplied by the third nerve through the ophthalmic ganglion

Dilator pupillæ, consisting of the radiating muscular fibers converging from the circumference of the iris toward the pupillary margin, where they blend with the circular fibers; it is supplied by sympathetic fibers from the ophthalmic ganglion.

Membrana pupillaris, a delicate, transparent, vascular membrane which occluded the pupil in the fetus, usually disappearing about the eighth fetal month, but occasionally persisting; it is nourished by many small vessels continued from the margin of the iris to those on the front part of the lens-capsule.

Arteries are branches of the long and anterior ciliary forming the circulus iridis major and minor (see p. 194).

Veins empty into those of the ciliary processes and into the anterior and long ciliary veins, and communicate with the canal of Schlemm.

Nerves are branches of the ciliary ganglion, from the nasal branch of the ophthalmic division of the fifth, the third nerve going to the sphincter pupillæ (circular fibers), the sympathetic to the dilator pupillæ (radiating fibers), and the fifth supplying common sensation.

What is the retina?

The innermost ocular tunic, forming a delicate, grayish, transparent, nervous membrane, *pars optica retinæ*, ending near the ciliary body by a ragged margin, the *ora serrata;* its fibrous stroma, covered by the pigment-layer, passes forward to the ciliary margin of the iris as the *pars ciliaris retinæ;* behind the iris is the *pars iridica retinæ.*

Macula lutea, or yellow spot of *Sömmering*, is an elliptical, elevated spot exactly in the center of the retina posteriorly, which corresponds to the axis of the eye; here vision is most perfect, the retina being thin and crowded with nerve-elements, but destitute of rods and the nerve-fiber layer; the diameter is 1 to 2 mm.

Fovea centralis is a minute central depression at the summit of the yellow spot; the diameter is 0.2 mm. to 0.4 mm.

Porus opticus is a disk at the point of entrance of the optic nerve, centrally pierced by the arteria centralis retinæ, lying about $\frac{1}{10}$ inch (3 mm.) to the inner side of the yellow spot and 1 mm. below its level; it is the only portion of the retina where the sense of vision is wanting, the *blind spot;* the margin of the disk is elevated, called the *colliculus nervi optici.*

Pars ciliaris retinæ consists of the fibrous and pigmented portions of the retina, destitute of nerve-elements, continued over the ciliary processes from the ora serrata to the iris; the

Arteries of the retina spring from the arteria centralis retinæ, a branch of the ophthalmic, which after piercing the optic nerve divides into four or five branches, which soon enter the nervous layer of the retina to form a fine capillary plexus not extending beyond the inner nuclear layer; no vessels exist in the fovea centralis, very few in the macula lutea; there are no anastomoses.

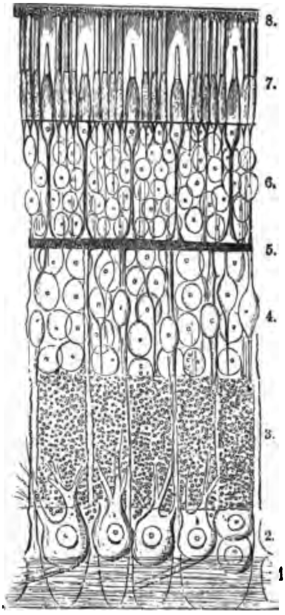


FIG. 138.—The layers of the retina (diagrammatic).

Describe the structure of the retina.

It is exceedingly complex, being composed from within outward of ten layers, or properly eight, two being boundary lines (Fig. 138).

Membrana limitans interna, a transparent membrane formed of retinal connective tissue, lying in contact with the hyaloid membrane of the vitreous humor.

1. *Nerve-fiber layer,* composed of continuations of optic fibers deprived of their medullary sheaths, forming radiating bundles or plexuses joining the next layer.

2. *Ganglionic layer,* a single layer of large ganglion-cells,

except at the macula lutea, where there are several layers; they have one process prolonged into the fibrous layer, becoming continuous with a nerve-fibril, and one or more extending into the inner molecular layer, or (according to some) passing through it to terminate in the nuclear layer.

3. *Inner molecular* or *reticular layer*, made up of a reticulum of fibrils, mingled with processes of the ganglion-cells and those of the next layer, containing in the interstices minute clear granules.

4. *Inner nuclear layer*, containing (1) *bipolar cells* with oval nuclei, one process passing to the inner molecular layer, believed to become continuous with the processes of the ganglion-cells, and another passing into the outer molecular layer, there bifurcating and (according to some) communicating with rod and cone fibers; (2) nucleated cells without branches; (3) cells connected with the fibers of Müller.

5. *Outer molecular layer* is thinner, resembles the inner molecular layer, but contains branched stellate cells—probably ganglion-cells.

6. *Outer nuclear layer* consists of (1) *rod-granules*, transversely striated cells, with an external fine process connected with a single rod of Jacob's membrane, and an internal prolongation which enlarges, then breaks up into minute fibrils entering the outer molecular layer; and (2) *cone-granules*, closely connected with the cones of Jacob's membrane, with a thick process passing inward, becoming bulbous (*cone-foot*) and terminating by numerous fibrillæ, which enter the outer molecular layer.

External limiting membrane, a membrane formed of retinal connective tissue, perforated by numerous openings.

7. *Jacob's membrane* or *rods and cones*, composed of *rods* arranged perpendicularly to the surface, each composed of an outer and an inner portion joined by cement-substance; and *cones*, with apices directed toward the choroid, formed of two portions, and like the rods having their outer segments transversely striated; this is probably the perceptive layer of the retina.

8. *Pigmentary layer*, formerly considered a part of the choroid, consisting of a single layer of hexagonal, pigmented epithelial cells.

The connective tissue uniting the layers is a fenestrated, sponge-like structure, the *membrane of Müller*.

The Humors.

What is the aqueous humor?

A small amount of clear alkaline fluid composed of water, 96.7 per cent.; albumin, 0.1; sodium chlorid and extractive, 3.2; filling the anterior and posterior aqueous chambers of the eye.

What are the anterior and the posterior aqueous chambers?

The *anterior chamber* is a space filled with aqueous humor bounded in front by the cornea, behind by the front of the iris, and communicating through the pupil with the

Posterior chamber, also filled with aqueous humor; it is only a narrow chink between the peripheral portion of the iris, the suspensory ligament, and the ciliary processes; the chambers are separate in the fetus.

Describe the vitreous body.

This forms about four-fifths of the entire globe, is transparent, of the consistence of thin jelly, composed of water, 98.5 per cent., a few salts, and a trace of albumin, and is enclosed everywhere in a delicate *hyaloid membrane*, beneath which are small, granular, ameboid cells; it possesses neither vessels nor nerves, and has the *fossa patellaris* in front, where the crystalline lens reposes. Running from the entrance of the optic nerve to the posterior surface of the crystalline lens is the *canal of Stilling*, or *hyaloid canal*, filled with fluid and lined with hyaloid membrane; it once carried a fetal artery.

Describe the crystalline lens with its ligaments.

It is a transparent double convex body, more convex posteriorly than in front, enclosed in a *capsule*, and is lodged in a depression of the hyaloid membrane, where it is retained by its suspensory ligament. It lies immediately behind the pupil surrounded and slightly overlapped by the ciliary processes, measuring about one-third of an inch transversely by one-fourth of an inch antero-posteriorly, and is composed of water, albuminous matter, fat, and cholesterin. The center of each surface is the *pole;* the surfaces meet in a rounded border, the *equator*.

Capsule is transparent, very elastic, and brittle, measuring $\frac{1}{2000}$ inch in front, $\frac{1}{6000}$ inch behind, and is attached anteriorly to the lens by a single layer of polygonal cells; posteriorly between the lens and the capsule this layer is lacking; here fluid may collect post mortem, *liquor Morgagni.*

At the ora serrata the hyaloid membrane splits into two layers; one passes behind the lens in front of the vitreous humor, which is completely invested; the other layer continues over the ciliary body and pars ciliaris retinæ, and is called the *zonula of Zinn;* its free part extends from the ciliary body to the lens-capsule, and is called the *suspensory ligament* of the lens.

Due to plications of the ciliary body over which the zonula is reflected there are two sets of fibers in the suspensory ligament; one comes from the zonula as it lies on the *summits* of the ciliary processes, and goes to the periphery of the lens and adjoining part of its posterior capsule; the set arising from the *valleys* between the ciliary processes passes to the anterior capsule of the lens. These sets partially cross each other at their origins.

Canal of Petit, triangular on section, passes around the circumference of the lens, bounded in front by anterior fibers of the suspensory ligament, behind by the hyaloid membrane, mesially by the capsule of the lens; when inflated it becomes sacculated.

What is the structure of the crystalline lens?

It is formed of numerous laminæ, composed of six-sided fibers $\frac{1}{5000}$ inch broad (0.005 mm.), with serrated margins, those of contiguous fibers accurately fitting one another; the lens is also divisible into three triangular segments with their bases outward. Each surface shows three *rays* of a *star* at angles of 120°. The central harder portion is called the *nucleus*, the peripheral portions the *cortex;* it possesses neither vessels nor nerves.

Describe the muscles of the eyeball (Fig. 139).

Rectus superior[4]: *origin*, upper margin of the optic foramen and sheath of the optic nerve; *insertion*, sclerotic coat three or four lines from the cornea; *action*, turns the eyeball upward and inward; *nerve*, third cranial.

Rectus inferior[5]: *origin*, ligament of Zinn; *insertion*, sclerotic, three or four lines from the cornea; *action*, turns the eye downward and inward; *nerve*, third cranial.

Rectus internus: *origin*, ligament of Zinn at the inner side of the optic foramen; *insertion*, the sclerotic, three or four lines from the cornea; *action*, turns the eye inward; *nerve*, third cranial.

Rectus externus[6]: *origin*, by two heads, the upper[8] from the outer margin of the optic foramen, the lower[7] from the ligament of Zinn, and a pointed bony process at the lower margin of the sphenoidal fissure; *insertion*, sclerotic, as the other recti; *action*, turns the eye outward; *nerve*, sixth cranial (abducens); between the two heads pass the ophthalmic vein, the third, the nasal branch of the fifth, and the sixth cranial nerves.

Obliquus superior[2]: *origin*, one line above the inner margin of the optic foramen, terminating in a rounded tendon which plays through a fibro-cartilaginous ring or pulley[3] beneath the internal angular process of the frontal bone, whence it passes beneath the superior rectus; *insertion*, sclerotic between the superior and the external recti, midway between the cornea and the entrance of the optic nerve; *action*, rotates the eye on its antero-posterior axis and corrects inward deviation of the inferior rectus; *nerve*, fourth cranial (patheticus).

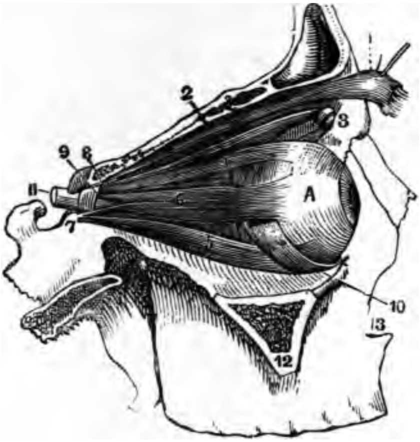


FIG. 139.—Muscles of the right orbit (Leidy).

Obliquus inferior[10]: *origin*, orbital plate of the superior maxilla; *insertion*, sclerotic between the superior and the external recti; *action*, rotates the eyeball outward and corrects inward rotation of the superior rectus; *nerve*, third cranial.

(For the muscles of the lids see p. 142.)

Recapitulate the nerve-supply of the ocular muscles.

Third cranial, or *motor oculi*, supplies the superior, internal, and inferior recti, and the inferior oblique muscles.

Fourth cranial, or *patheticus*, supplies the superior oblique muscle.

Sixth cranial, or *abducens*, supplies the external rectus muscle.

Describe the vascular supply of the eyeball and its appendages.

(All branches of the vessels not supplying these parts *will be omitted*, having been already described on pages 191 to 194.)

Ophthalmic, arising from the cavernous portion of the internal carotid, entering the orbit by the optic foramen, giving off the

Lacrimal to the lacrimal gland, conjunctiva, and upper eyelid, and inosculating with the palpebral arteries.

Supraorbital supplies the levator palpebræ and superior rectus muscles.

Superior and *inferior palpebral* supply the eyelids.

Nasal supplies the lacrimal sac.

Short ciliary, six to twelve in number, penetrate the sclerotic around the optic nerve entrance to supply the choroid and ciliary processes.

Long ciliary, two in number, penetrate the sclerotic, pass forward between it and the choroid to supply the iris, forming the *circulus iridis major* near the ciliary margin, and the *circulus iridis minor* near the margin of the pupil.

Anterior ciliary, six to eight, spring from the muscular branches, perforate the sclerotic, and join the circulus iridis major.

Arteria centralis retinæ obliquely traverses the optic nerve to be distributed to the retina.

Muscular branches, one superior, one inferior, to the ocular muscles.

Infraorbital, from the internal maxillary, supplies the inferior rectus and inferior oblique muscles and lacrimal gland.

What are the chief lymph-spaces of the eyeball?

Anterior and *posterior aqueous chambers*, *spaces of Fontana*, *Schlemm's* and *Petit's canals*, *lymph-spaces* of the cornea and iris, *hyaloid canal*, *perivascular canals* of the retina, *perichoroidal space* between the choroid and the sclerotic, *cavity of the capsule of Tenon* between the eyeball and the capsule, *supravaginal* and *intervaginal spaces* of the optic nerve.

What veins return the blood from the eye?

The *superior* and *inferior ophthalmic*, emptying usually by a short common trunk into the cavernous sinus; they also freely anastomose with the angular vein of the face.

Name the nerves of the eye.

Optic or *second cranial*, nerve of the special sense of sight.

Motor nerves, the *third*, *fourth*, and *sixth cranial.*

The *ophthalmic division of the fifth* supplies general sensation by the

Lacrimal, to the same named gland, conjunctiva, and skin of the upper eyelid; also the following branches: *frontal*, which gives the *supratrochlear*, and *supraorbital*, *nasal* with its *ganglionic*, *long ciliary*, and *infratrochlear* branches. *Orbital* or temporo-malar nerve from the second division of the fifth also enters the orbit.

The *sympathetic* arises from the cavernous and carotid plexus, receiving communicating filaments indirectly from the spinal nerves, and sending branches to the third, fourth, fifth, and sixth nerves; the dilator fibers (radiating) of the iris, ciliary ganglion, muscles of the orbit and lids, with the walls of the arteries, receive their sympathetic nerve-supply from this source; the

Short ciliary, numbering six or eight, arise from the ciliary ganglion, subdivide into twelve to twenty fine filaments and pierce the sclerotic posteriorly in two bundles, to ramify in the sheath of the optic nerve, choroid, ciliary muscle, iris, and cornea.

Ascending branches of the spheno-palatine (*Meckel's*) *ganglion*, reaching the orbit by the spheno-maxillary fissure, usually supply the periosteum, send a twig to the optic nerve (Arnold), to the sixth nerve (Bock), to the ciliary ganglion (Tiedemann).

Give a brief description of the optic tracts.

The deep origins of the nerve-fibers of these tracts are the optic thalami, corpora geniculata, upper pair of the corpora quadrigemina, which, forming two flattened bands, wind around the crura cerebri, to which they are slightly attached, as well as to the lamina cinerea and tuber cinereum, and joining in front of the latter they form the *optic commissure* (see pages 241 and 242 for illustration and more elaborate description).

What are the origin and course of the optic nerves?

They arise on either side from the optic commissure; each passes into the orbit through the optic foramen with the central artery of the retina, which pierces it, and enters the eyeball through the lamina cribrosa $\frac{1}{10}$ inch (3 mm.) to the nasal side of the yellow spot and 1 mm. below it; these nerves are surrounded with a sheath derived from the dura mater, between which and the nerve is a lymph-space communicating with the subarachnoid and subdural spaces.

The Appendages of the Eye.

(Tutamina Oculi.)

Name these.

Eyebrows, or *supercilia*,
Eyelids, or *palpebræ*,
Conjunctiva[a], a mucous membrane,
Lacrimal gland[1] and *ducts*,
Lacrimal sac and *canaliculi*,
Nasal duct.

What are the eyebrows?

The arched eminences of skin surmounting the upper margins of the orbits on each side, from which grow several rows of short, obliquely placed hairs; by the attached muscles the eyebrows can partially shut off light from the eyes.

What are the eyelids?

Two movable curtains protecting by their closure the eyes from injury; the upper lid is the larger and more movable, having its own elevator muscle, *levator palpebræ;* the

Palpebral fissure is the elliptical space between the margins of the lids when opened, the internal and external angles being called, respectively, the *internal* and the *external canthus*, the former being prolonged inward, leaving a triangular space between the lids, the *lacus lacrimalis*, at the commencement of which is a small elevation on each lid, the *lacrimal papilla*[3], whose summit is pierced by a minute opening, the *punctum lacrimale*[3], the commencement of the lacrimal canal.

What structures form the eyelids?

Externally the skin, beneath which is much loose areolar tissue, separating it from the fibers of the *orbicularis palpebrarum muscle.* The lids retain their shape by means of the so-called *tarsal cartilages*—in reality dense connective tissue *without* cartilage-cells—that for the upper lid being half-oval and the larger, that for the lower lid narrower; these structures are connected at their orbital margins with the circumference of the orbit by fibrous membranes, the *tarsal ligaments ;* the *internal palpebral* (*tarsal*) *ligament*, or *tendo oculi*, passes from the inner angle of each to the nasal process of the superior maxilla; the *external palpebral ligament* passes to the malar bone.

Embedded in the ocular surface of the cartilages are sebaceous glands, the *Meibomian*, discharging their secretion upon the free edge of the lids, preventing their adhesion; they number thirty or forty in the upper lid, are fewer in the lower lid.

Attached to the free margins of the lids is a double or triple row of stiff hairs, curved in each lid so that their convexities meet, preventing interlacing; these are the *cilia*, or *eyelashes ;* just within this line is a row of modified sweat-glands, the *glands of Moll.*

The *arteries* are two internal palpebrals from the ophthalmic, two external palpebrals from the lacrimal, the transverse facial, and the superficial temporal.

The *nerves* are the third, seventh, and the sympathetic to the muscles, the ophthalmic branch of the fifth to the skin and the conjunctiva.

Describe the conjunctiva.

It is a mucous membrane lining the inner surfaces of the eyelids and reflected thence, *fornix conjunctivæ*, upon the anterior segment of the sclerotic, its epithelial layer passing over the cornea.

The *palpebral conjunctiva* is thick, opaque, vascular, and covered with papillæ, containing numerous glands; at the inner angle of the eye it forms a vertical semilunar fold, the *plica semilunaris*[4]. The folds formed by the passage of the conjunctiva from the lids to the eyeball are called the *superior* and *inferior palpebral folds*, the former being the deeper; they contain numerous convoluted mucous glands, some of which resemble lymphoid follicles.

The *ocular conjunctiva* is thin, transparent, possesses few vessels in health, and is loosely attached to the globe by the subconjunctival areolar tissue.

The *corneal conjunctiva* consists only of epithelium.

What is the caruncula lacrimalis[5] (Fig. 141)?

It is a small, conical, reddish body, at the inner canthus, occupying the space called the lacus lacrimalis, and is formed of a group of follicles, sebaceous and sweat-glands, covered with skin; from the caruncle project a few slender hairs.

Describe the lacrimal apparatus.

It consists of the lacrimal gland with its ducts, the canaliculi, the lacrimal sac, and the nasal duct. The

Lacrimal gland[1] (Fig. 140) is an oval, compound racemose gland of the size and shape of an almond, lodged in a depression at the upper, outer portion of the orbit, its concave under surface resting upon the globe of the eye, the conjunctiva, superior and external recti muscles intervening; it is held in contact with the orbital periosteum by a few fibrous bands; it has two parts, the smaller one called the *inferior lacrimal gland.* It has never more than twelve

Ducts[2], opening by minute orifices in a row on the upper and outer part of the conjunctival fornix.

Tears are taken up by the puncta, thence passing through the canaliculi into the lacrimal sac and nasal duct, thus reaching the inferior meatus of the nose.

Describe the canaliculi.

They are two minute canals[1] about one-half a line in diameter, commencing at the puncta; the superior passing upward, then bending acutely to pass inward to the lacrimal sac; the inferior passing downward, then upward and inward; they are lined with mucous membrane continuous with the conjunctiva, and are one-third of an inch long (8 to 9 mm.).

What is the lacrimal sac[2] (Fig. 141)?

It is the flattened, ovoidal, sacciform dilatation of the upper part of the nasal duct, lodged in the groove formed by the lacrimal bone and nasal process of the superior maxillary; its walls are formed of fibrous tissue covered internally by the tensor tarsi muscle, and in front is the tendo oculi attached to the ridge of the lacrimal bone. When distended it is 15 mm. long and 5 or 6 mm. wide.

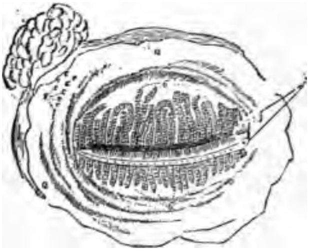


FIG. 140.—The lacrimal gland and Meibomian glands, seen from the inner surface of the eyelids (Leidy).

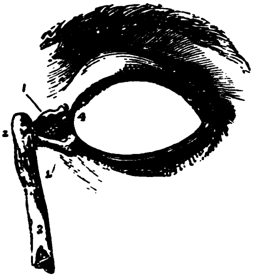


FIG. 141.—The lacrimal apparatus, left side (Leidy).

Describe the nasal duct[3].

It is a membranous canal about three-fourths of an inch long (12 to 24 mm.), extending from the termination of the lacrimal sac through the osseous nasal duct to the inferior meatus of the nose, passing in a direction downward, backward, and slightly outward, its lumen being narrowest about the midpoint; externally it is composed of fibro-areolar tissue; internally, of mucous membrane continuous with that of the nose and lacrimal sac; the epithelial coating of the sac and duct is columnar and ciliated only in spots; squamous in the canaliculi.

What is the valve of Hasner?

An imperfect valve of mucous membrane guarding the somewhat expanded terminal opening of the duct into the inferior meatus of the nose; other valvular folds are less constant.

The Ear.

Where is the auditory apparatus lodged?

In the petrous, mastoid, and tympanic portions of the temporal bone.

Enumerate the divisions.

The *external ear*, comprising .	*Auricle*, or *pinna*, *External auditory canal.*
The *middle ear*, or *tympanum*, comprising	*Membrana tympani*, *Cavity of tympanum*, *Mastoid cells*, *Eustachian tube.*
The *internal ear*, or *labyrinth*, comprising	*Vestibule*, *Semicircular canals*, *Cochlea*, *Auditory nerve.*

The External Ear.

What is the auricle or pinna?

Its foundation is an expanded layer of fibro-cartilage, so disposed in ridges as to concentrate and direct the waves of sound into the external auditory meatus, to which it is attached; the cartilage is deficient at certain points where it is connected by fibrous tissue; it is covered with perichondrium, outside of which is thin, firmly adherent skin, containing sweat- and sebaceous glands, and provided with short downy hairs. The various ridges and depressions are as follows: the

Concha, the deep cavity leading into the meatus; the

Tragus, the pointed prominence in front of the concha projecting back over the meatus, bearing on its under surface tufts of hair; the

Antitragus, a small tubercle opposite the tragus, separated by a deep notch, the *incisura intertragica;* the

Helix, the external prominent margin of the auricle rising near the tragus; the

Antihelix, a parallel prominence anterior to the former, rising below at the antitragus, bifurcating above to form the

Fossa of the antihelix, a triangular depression; the

Fossa of the helix, the narrow, curved depression between the helix and the antihelix (*fossa scaphoidea*).

An *ear-point*, or *tubercle of Darwin*, is occasionally seen on the postero-superior margin of the helix pointing forward; it is constant in the human embryo, and permanent in many monkeys.

The inferior, soft pendulous portion, formed of fat and connective tissue enclosed by integument, is the *lobule* of the ear.

Describe the muscles of the external ear.

The attollens aurem, attrahens aurem, and retrahens aurem have been described on page 142; these are extrinsic; the intrinsic are the muscles of the auricle, but slightly developed in man; their motor nerve is the facial.

Helicis major: a narrow vertical band on the anterior border of the helix;

Helicis minor: an oblique band at the root of the helix from the concha;

Tragicus: a short, vertical band on the outer surface of the tragus;

Antitragicus: stretching from the outer part of the antitragus to the lower part of the helix; these four muscles are anterior.

Transversus auriculæ: radiating from the posterior surface of the convexity of the concha to the prominence caused by the groove of the helix;

Obliquus auris: a few fibers passing from the upper back part of the concha to the convexity immediately above.

Give the vascular and nerve-supply to the auricle.

The arteries are *Posterior auricular*, from the external carotid.
Anterior auricular, branch of the temporal.
Auricular, branch of the occipital.

The veins accompany the corresponding arteries.

The nerves are *Auricularis magnus*, from the cervical plexus.
Posterior auricular, from the facial.
Auricular branch (Arnold's) of the pneumogastric.
Auriculo-temporal, from the inferior maxillary division of the fifth nerve.
Occipitalis major and *minor*.

What is the external auditory canal?

It is an osseo-cartilaginous, oval, cylindrical canal, with its greatest diameter vertical at the external orifice, but reversed at the tympanic end; it is narrowest at the middle. About one inch long (25 mm.), it is directed obliquely forward and inward, and slightly curved with its convexity upward, and is lined with thin adherent skin, containing hair-follicles and sebaceous and ceruminous glands in its cartilaginous portion. A narrow groove for the membrana tympani is at the inner end, called the *sulcus tympanicus*, interrupted above by the *notch of Rivinus* between the *anterior* and the *posterior tympanic spines.*

What are the arteries and nerves?

The *arteries* are branches of the posterior auricular, internal maxillary, and temporal.

The *nerves* come chiefly from the auriculo-temporal branch of the third division of the fifth nerve and from the auricular branch of the vagus.

The Middle Ear or Tympanum.

Describe the membrana tympani.

It forms the outer wall of the tympanum, and is an oval, translucent membrane placed obliquely at the bottom of the external auditory meatus, with its internal surface facing downward, forward, and inward at an angle of 55°,with its long axis directed downward and inward; it inclines toward the anterior and lower part of the canal; at its upper anterior border is a white, pointed *tubercle*, formed by the short process of the malleus, while a yellowish-white stripe passing from this downward and backward toward the center indicates the handle of the malleus. During life, when illuminated, the membrana tympani presents a triangular *light spot* or "*cone of light*," having its apex at the end of the malleus handle, whence it spreads downward and forward; a darker central portion is the *umbo*, or shadow. The upper anterior part bridging a small notch in the bony ring to which the membrane is attached (the notch of Rivinus), is thin, consisting of loose connective tissue, vessels, and nerves, covered with skin and mucous membrane, and has received the name of the *membrana flaccida*, or *Shrapnell's membrane.*

Of what tissues is the membrana tympani composed?

Of the skin, which is derived from the lining of the meatus;

of a fibrous layer, some of whose fibers radiate from near the center to the circumference, others form a dense ring around the attached margin; and of mucous membrane, derived from that lining the tympanum. The handle of the malleus passes between the inner and the middle layers—according to von Tröltsch, it is received *between* the circular and the radiating fibers of the middle coat; an *anterior* and a *posterior pouch* have also been described upon the external surface opening downward. The radial fibers are slightly bowed outward, so that between the depressed umbo and the attached border the membrane is convex externally, due to annular fibers.

Describe the arterial supply of the membrana tympani.

The *deep auricular* branch of the internal maxillary supplies the external layers, forming a plexus which communicates at the periphery with one in the mucous membrane formed from the

Tympanic branches of the internal maxillary and internal carotid arteries, and by the

Tympanic branch of the *Vidian*, from the internal maxillary, and the

Stylo-mastoid, from the posterior auricular.

Mention the nerves supplying the membrana tympani.

To the upper portion run filaments from the *auriculo-temporal* branch of the fifth, to the lower portion, the *auricular branch of the vagus*, while the mucous layer is supplied by the *tympanic* plexus.

The Tympanum.

Describe it.

It is an irregular cavity, measuring about one-half inch antero-posteriorly, one-third inch vertically, and one-fifth inch transversely, situated in the petrous bone, compressed from without inward, being placed above the jugular fossa, having the carotid canal in front, the mastoid cells behind, the external meatus externally, and the labyrinth internally; it communicates in front with the pharynx by the Eustachian tube, and presents for examination the following points: the

Roof, a very thin plate of bone, indicated on the cranial surface by a depression on the anterior surface of the petrous portion of the temporal bone, the *tegmen tympani;* the

Floor, narrow, corresponding to the jugular fossa, and presenting near the inner wall a small *foramen for Jacobson's nerve;* the

Outer wall, the membrana tympani and bony ring to which it is attached, presenting three small orifices, the

Iter chordæ posterius, opening in the angle of the junction between the posterior and external walls, just behind the membrana tympani on a level with its center, for the entrance of the chorda tympani nerve; the

Glaserian fissure, *petro-tympanic*, just above and in front of the bony ring, giving passage to some tympanic vessels, the tympanic branch of the internal maxillary artery, and lodgment of the long process of the malleus; the

Iter chordæ anterius, or *canal of Huguier*, opening just above the preceding, for the *escape* of the chorda tympani nerve; the

Inner wall is vertical, looking directly outward, and presents the

Fenestra ovalis or *oval window*, a kidney-shaped opening leading into the vestibule, closed by the base of the stapes with its ligament; the

Fenestra rotunda or *round window*, below, at the bottom of a funnel-shaped depression, opening into the scala tympani of the cochlea, closed by the *membrana tympani secundaria*, having mucous, fibrous, and serous layers.

Promontory, a rounded hollow eminence—the first turn of the cochlea—situated between the oval and the round windows, and presenting grooves lodging branches of the tympanic plexus; the

Eminence of the aquæductus Fallopii passes above the oval window, along the inner tympanic wall, to curve behind that opening nearly vertically downward along the posterior wall; the

Posterior wall presents the opening of the mastoid antrum.

Pyramid, a hollow conical projection, behind the oval window and in front of the vertical portion of the aquæductus Fallopii, contains the stapedius muscle, whose tendon escapes from its summit; a minute canal communicates with the aquæductus Fallopii, transmitting a twig of the facial nerve to the stapedius muscle; the

Opening of the *mastoid antrum* is above the pyramid in the *attic*.

The *anterior wall* is wider above than below, is related to the carotid canal, the thin bony partition being perforated by the tympanic branch of the internal carotid artery; it presents two openings: the

Orifice of the canal for the tensor tympani muscle, which is situated above, close to the Eustachian tube, on the summit of a small conical eminence, *the processus cochleariformis;* the

Opening of the Eustachian tube is immediately below the preceding, separated partially by a thin bony plate, the *septum tubæ.*

What are the ossicles of the tympanum?

Three bones forming a movable chain, passing between the membrana tympani and the oval window (Fig. 142), called the

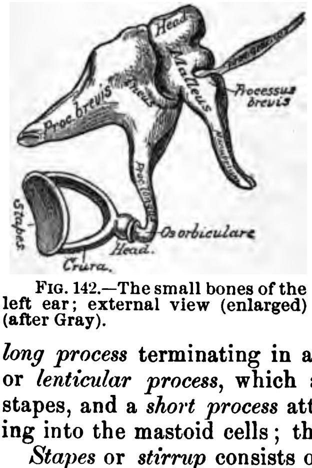


FIG. 142.—The small bones of the left ear; external view (enlarged) (after Gray).

Malleus or *hammer*, consisting of an oval *head* articulating with the incus, a *neck*, a *manubrium* or handle, affording attachment near its root to the tensor tympani muscle, a short process, *processus brevis*, coming in contact with the membrana tympani, and a *processus gracilis* or long process, lodged in the Glaserian fissure, and fastened by bony or ligamentous attachment; the

Incus or *anvil*, having a *body* articulating with the malleus, a *long process* terminating in a rounded end, the *os orbiculare*, or *lenticular process*, which articulates with the head of the stapes, and a *short process* attached to the margin of the opening into the mastoid cells; the

Stapes or *stirrup* consists of a *head* articulating with the os orbiculare, a *neck* receiving the insertion of the stapedius muscle, two branches or *crura* joining the oval *base*, which latter is connected with the margins of the oval window by ligamentous fibers.

Describe the ligaments of the ossicles.

The *suspensory ligament of the malleus*, passing between the tympanic roof and the head of the malleus; the *anterior liga-*

ment of the malleus goes from its neck to the anterior wall near the Glaserian fissure; the *external ligament of the malleus*, fan-shaped, converges from the margin of the notch of Rivinus to the processus brevis.

The *posterior ligament of the incus*, passing between the posterior tympanic wall near the margin of the opening into the mastoid cells and end of the short process of the incus; the *suspensory ligament of the incus*, descending from the tympanic roof to the incus, near its articulation with the malleus; the

Annular ligament of the stapes, connecting the circumference of its base to the margins of the oval window; the

Capsular ligaments, around the articulations between the incus and the malleus, os orbiculare and stapes, these joints having their surfaces coated with hyaline cartilage and being provided with synovial membranes.

Other ligaments have been described under special names, as accessory anterior and inferior ligaments of the malleus, and the *obturator ligament* of the stapes, this latter being a membrane filling up the opening between the crura of the stapes.

Describe the muscles of the tympanum.

Only two are well recognized. Sömmering described four, others have mentioned still more; but further research proves them to be ligamentous or fascial; the major and minor laxator tympani muscles are now described as ligaments of the malleus.

Tensor tympani: *origin*, under surface of the petrous bone, adjoining portion of the cartilaginous Eustachian tube, its own osseous canal; it makes a sharp bend outward around the end of the processus cochleariformis; *insertion*, handle of the malleus near the root; *action*, draws the membrana tympani inward—*i. e.* increases *tension*; *nerve*, by a twig to the internal pterygoid muscle through the otic ganglion.

Stapedius: *origin*, from the interior of the pyramid; *insertion*, neck of the stapes; its tendon may contain a bony spine; *action*, compresses the contents of the vestibule; it pushes the hinder part of the base of the stapes into the vestibule and draws the fore-part from it; *nerve*, filament of the facial.

Describe the arterial supply of the tympanum.

These arteries are about six in number; two are large, and form a vascular circle on the margin of the membrana tympani. The *tympanic branch* of the internal maxillary enters by the Glaserian fissure and is distributed to the membrana tympani, joining the

Stylo-mastoid, from the posterior auricular to the back part of the tympanum and mastoid cells. This enters by the stylomastoid foramen. Other small branches are the *petrosal*, from the middle meningeal, entering through the hiatus Fallopii; the

Tympanic, from the internal carotid, perforating the thin bony wall; the

Tympanic branch of the Vidian, from the internal maxillary and a

Branch from the ascending pharyngeal, both by the Eustachian tube.

What nerves supply the tympanum?

The *tympanic branch of the glosso-pharyngeal* (Jacobson's nerve), which pierces the floor of the tympanum, and aids in forming the *tympanic plexus*, which supplies the fenestræ, mucous membrane, and Eustachian tube; the

Tympanic branch of the facial, supplying the stapedius muscle; the

Branch from the otic ganglion, supplying the tensor tympani muscle.

(The *chorda tympani from the facial*, passing into the tympanum by the iter chordæ posterius, emerging by the iter chordæ anterius, arching across the cavity between the handle of the malleus and the long process of the incus; it is covered with mucous membrane and gives off no branches.)

Describe the formation of the tympanic plexus.

The plexus occupies shallow grooves on the inner wall of the middle ear, especially on the promontory, and is formed by (1) *Jacobson's nerve* from the petrosal ganglion of the glosso-pharyngeal; (2) the *small deep petrosal* (*carotico-tympanicus superior*) runs in the processus cochleariformis, enters the foramen lacerum (middle lacerated), and joins the sympathetic plexus on the carotid artery; (3) a branch joins the great superficial petrosal nerve in the hiatus Fallopii; (4) the *small superficial petrosal* receives a filament from the geniculate ganglion of the facial and passes to the otic ganglion; (5) the *carotico-tympanicus inferior* is a sympathetic twig (or twigs) passing up from the carotid plexus to the tympanic plexus.

Describe the Eustachian tube.

It is about one and one-half inches (36 mm.) long, passing downward at an angle of 30° from the horizontal, forward and inward at an angle of 45°, the passage by which the air in the middle ear freely communicates with that in the pharynx, thus permitting equal pressures on the tympanic membrane. It consists of about one-third bone and two-thirds fibro-cartilage and fibrous tissue; their point of junction is the narrowest part of the tube, the *isthmus tubæ.*

The *osseous portion* is one-half inch long, commencing at the lower part of the anterior tympanic wall, gradually narrowing to terminate at the angle of junction of the petrous and squamous portions of the temporal bone.

The *cartilaginous portion* is about one inch long, formed by a triangular plate of elastic fibro-cartilage curved upon itself into a partial tube; but inferiorly the margins are not in contact, the defect being filled by fibrous and muscular tissue.

The *mucous membrane* is continuous with that of the pharynx, and is covered with ciliated epithelium, thick below and thin above.

Where is the pharyngeal orifice situated?

At the upper lateral portion of the pharynx behind the inferior turbinated bone, above the level of the nasal floor.

Has this tube any special muscles?

Spheno-staphylinus: *origin,* spine of the sphenoid and the cartilaginous tube; *insertion,* pharyngeal aponeurosis, or soft palate, palate bone near the posterior nasal spine, or hamular process; *nerve,* probably the pharyngeal plexus through the spinal accessory; *action,* lifts the palate or dilates the tube.

Salpingo-pharyngeus: a thin layer beneath the mucous membrane, rising from the cartilage of the tube, passing to the palato-pharyngeus muscle; *nerve* and *action* as given above.

Rare muscles: pterygo-salpingoideus, petro-staphylinus, palato-staphylinus, glosso-staphylinus. The levator and tensor palati muscles dilate the tube.

Give the arterial and nerve-supply of the Eustachian tube.

The *ascending pharyngeal*, from the external carotid.

Branches of the middle meningeal, from the internal maxillary.

Branch from the *stylo-mastoid artery.*

The *nerves* are, in addition to those supplying the muscles of the tube (supra), from the *fifth* and *seventh pairs* and the *spinal accessory.*

The Internal Ear, or Labyrinth.

Name its divisions.

The *osseous labyrinth*, consisting of	*Vestibule*[3] (Fig. 143), *Semicircular canals*[5,6,7], *Cochlea*[8].
The *membranous labyrinth*, consisting of	*Utricle*, *Membranous semicircular canals*, *Saccule*, *Membranous cochlea.*

The *internal auditory canal*, at the bottom of which is the *lamina cribrosa*, for the passage of the auditory nerve and vessels and the facial nerve.

The *auditory nerve*, eighth cranial (*portio mollis*), is the special nerve of hearing, distributed only to the internal ear.

The *organ of Corti* is what the retina is to the eye, viz. the terminal and receptive apparatus.

Describe the internal ear.

It is formed by a series of cavities excavated in the petrous bone, communicating externally with the middle ear by the round and oval windows, internally, with the internal auditory canal; within the osseous labyrinth, surrounded by the *perilymph*, is the

Membranous labyrinth—filled with endolymph—upon which the auditory nerve-filaments are distributed.

Describe the various subdivisions of the osseous labyrinth.

The *vestibule* is the common central cavity with which all parts of the internal ear communicate, placed behind the cochlea, in front of the semicircular canals, at the inner side of the tympanum; it is ovoid, measuring about one-fifth of an inch (5 mm.) from before backward, as well as from above downward, less from without inward, and presents

The *fenestra ovalis*, on its outer wall, closed in the fresh state by the base of the stapes and its ligament.

The *fovea hemispherica*[2], a small circular depression on its inner wall, perforated antero-inferiorly by several minute foramina for the auditory nerves to the saccule; the perforated plate is called the *macula cribrosa*.

The *crista vestibuli* is a vertical ridge behind the macula cribrosa; its anterior part is the *pyramidal eminence;* below, the crista divides and encloses the *fossa cochlearis* pierced by nerve-fibers.

The *aquæductus vestibuli*, at the back part of the inner wall, transmitting a small vein, and the *ductus endolymphaticus*, a tubular prolongation of the lining membrane of the vestibule, ending in a pouch in the cranial cavity between layers of the dura mater.

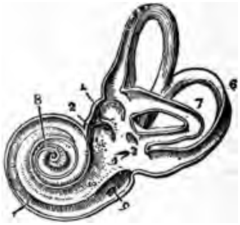


FIG. 143.—The left osseous labyrinth laid open; external view (enlarged) (Leidy).

The *fovea hemielliptica*[1], a transversely-oval depression on the roof, separated by the crista vestibuli from the fovea hemispherica.

The *orifices of the semicircular canals*[3], five in number, open behind.

The *apertura scalæ vestibuli cochleæ* is situated anteriorly.

Describe the semicircular canals[5],[6],[7].

They are three curved bony tubes, each describing the greater part of a circle or ellipse, of unequal lengths, of a diameter of $\frac{1}{18}$ inch (1.5 mm.), each lying at a right angle to the other two and presenting at one end a dilatation, or *ampulla*, nearly double the diameter of the tube (2.5 mm.); the

Superior semicircular canal[5] is vertical, describes about two-thirds of a circle, passes at right angles to the posterior surface of the petrous bone, and forms a projection upon its anterior surface; it is 20 mm. long; its outer end is its *ampulla*, opening separately into the vestibule; its inner undilated extremity joins with that of the

Posterior semicircular canal[6], opening by a common orifice at the back of the vestibule; this canal is also vertical, is nearly parallel to the posterior surface of the petrous bone, and is the longest (22 mm.), the dilated extremity opening at the lower back part of the vestibule; the

External, or *horizontal semicircular canal*[7], is the shortest (15 mm.), and is directed outward and backward; its ampullated end opens into the vestibule just above the oval window, its other extremity by a separate orifice at the upper back part of the vestibule.

Describe the cochlea.

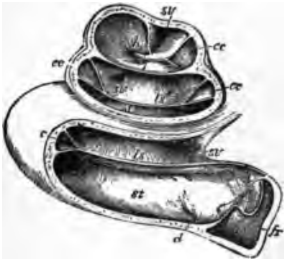


FIG. 144.—The left cochlea laid open (enlarged) (Leidy).

The *cochlea*[8] (Fig. 144) is conical, somewhat resembles a snail-shell, and forms the anterior part of the labyrinth; it is placed almost horizontally in front of the vestibule, its apex directed outward, forward, and downward, its base corresponding to the internal auditory meatus; its length is 5 mm., and breadth at base 9 mm. Viewed from its base, the right cochlea is coiled clockwise; it presents the

Modiolus, a central conical axis, perforated by numerous canals for filaments of the cochlear branch of the auditory nerve, its apex terminating in a delicate expanded lamella, like a funnel divided longitudinally, called the *infundibulum;* extending from base to apex is a canal, the *canalis centralis modioli*, for a small nerve and artery. Making two and one-half (two and three-fourths, Quain) spiral turns around the modiolus is the

Spiral canal[8], about one-twelfth of an inch (2 mm.) in diameter, and one and one-third inches (33 mm.) long, narrowing from base to apex, there forming the *cupola*, where the scala tympani and scala vestibuli, formed by the lamina spiralis, communicate by the *helicotrema.*

The *cochlea* presents three openings: the *fenestra rotunda*, connecting the scala tympani with the middle ear, an oval opening from the scala vestibuli into the vestibule, and that of the aquæductus cochleæ[9] for an emissary vein; projecting from the modiolus is the

Lamina spiralis[ls] (Fig. 144), a process formed of two bony lamellæ, between which are numerous canals for nerve-fibers, defective in the last half turn of the cochlea, leaving an aperture, the helicotrema, and terminating by the hook-like *hamular process*[h]; winding around the modiolus at the point of attachment of the lamina spiralis is the *canalis spiralis modioli*, lodging the enlargement of the cochlear nerve containing ganglion-cells, called the *ganglion spirale*, whence come the nerve-branches to the organ of Corti.

What is the scala vestibuli[sv] (Fig. 144)?

It is that portion of the canal of the cochlea above the lamina spiralis and membrane of Reissner, communicating with the vestibule below and the scala tympani above, by the helicotrema; it is filled with perilymph.

Describe the scala tympani[st].

It is that portion of the spiral canal below the lamina spiralis and the membranous cochlea, terminating below at the round window—which is closed by a membrane, the *membrana tympani secundaria*—and communicating above with the scala vestibuli at the helicotrema; it is filled with perilymph.

What is the aquæductus cochleæ[d]?

A small canal transmitting a vein from the cochlea to the inferior petrosal sinus, commencing at the lower wall of the scala tympani, and ending to the inner side of the carotid canal on the inferior surface of the petrous bone.

Describe and name the subdivisions of the membranous labyrinth (Fig. 145).

It consists of a series of closed membranous sacs containing *endolymph;* its various parts are called

The *vestibule*, consisting of the $\left\{\begin{array}{l}\textit{Utricle,}\\ \textit{Saccule,}\end{array}\right\}$ two membranous sacs, with the former of which communicate the three

Membranous semicircular canals.

The utricle and saccule are separate, but are indirectly connected by a minute canal passing from the saccule to a similar one from the utricle, forming the endolymphatic duct which passes along the aquæductus vestibuli to end by a blind pouch on the posterior surface of the petrous bone; the saccule communicates with the scala media by the *canalis reuniens.* The endolymph in all parts thus communicates freely.

Describe the utricle.

It is an oblong, laterally compressed sac, filled with endolymph, placed in the upper back part of the vestibule in the fovea hemielliptica, communicating behind with the membranous semicircular canals by five openings, and has distributed, chiefly at one part of its walls, numerous branches of the auditory nerve, at which point is a round mass of minute crystals of calcium carbonate, bound together by delicate fibrous tissue forming the *otoliths*, *otoconia*, or *ear-stones;* the thickening of the wall both of the utricle and saccule, where the nerves penetrate, is called the *macula acustica.*

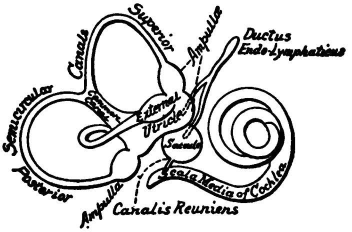


FIG. 145.—The right membranous labyrinth; external view (enlarged) (Gray).

What are the membranous semicircular canals?

They are three canals of the same shape, but one-fifth to one-third the diameter of the containing osseous canals, to which they are fastened by numerous fibrous bands; their five orifices open into the utricle. Each has three coats, *fibrous*, *tunica propria*, and an *epithelial lining.*

Describe the saccule.

It is a globular sac, smaller than the utricle, to which it is attached at one point, and lies in the fovea hemispherica; it is surrounded with perilymph, and indirectly communicates by a short canal with the utricle and with the membranous cochlea or *scala media* by the *canalis reuniens* of Hensen, a funnel-shaped duct, 1 mm. long, and 0.5 mm. wide. The saccule is 3 mm. long and 2 mm. broad; it contains a small bundle of otoliths; numerous nerves open on its floor upon a macula.

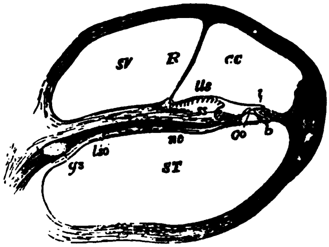


FIG. 146.—Section of the first turn of the cochlea, showing the three scalæ (enlarged). (Leidy)

What is the membranous canal of the cochlea^{cc} (Fig. 146)?

More usually called the *scala media*, *canalis cochleæ*, or the *ductus cochlearis*, it begins by a blind extremity at the lower anterior portion of the vestibule, enters the cochlea, where it forms in cross-section a triangular canal, its base being the outer wall of the cochlea, its lower wall the *membrana basilaris*^{b}, its upper the *membrane of Reissner*^{r}; it is filled with endolymph and contains the *organ of Corti*^{cc}, covered by the delicate *membrana tectoria*^{t} parallel with the basilar membrane^{b}. The periosteum on the upper surface of the osseous spiral lamina forms an elevation, the

Limbus laminæ spiralis^{lls}, which presents an upper and a lower margin called respectively the *labium vestibulare* and *labium tympanicum*, the groove formed between these being termed the *sulcus spiralis*^{s}, shaped like the letter C.

What is the membrane of Reissner^{r}**?**

A delicate membrane stretched between the outer wall of the cochlea and the periosteum of the vestibular surface of the osseous spiral lamina near the commencement of the limbus laminæ spiralis^{lls}, forming the upper wall of the scala media.

What is the membrana basilaris^{b}?

A thin membrane passing from the labium tympanicum to the wall of the cochlea, where it expands into the triangular *ligamentum spirale*^{lsp}. It forms a part of the floor of the scala media, supporting on its upper surface the organ of Corti^{co}.

Describe the membrana tectoria or membrane of Corti^{t}.

A delicate membrane rising from the upper surface of the limbus near the attachment of the membrane of Reissner^{r}, passes over the superior labium, and dips down into the spiral groove like a pad; it runs nearly parallel with the basilar membrane^{b}, rests upon the organ of Corti^{co}, and ends in the outer hair-cell region.

Describe the organ of Corti^{cc} (Fig. 147).

It consists of a complex body formed by a series of some three thousand arches roofing over a space called the *zona arcuata*, formed of rods and epithelial hair-cells, lying upon the membrana basilaris^{b} and covered by the membrana tectoria^{t}; the

Rods of Corti are disposed in two rows, the *inner*^{ir} and *outer*^{er} *rods*, each rod with its swollen base resting upon the basilar membrane^{b}, and its expanded upper end inclined toward and in contact with the opposite one, forming an arched canal; the upper end of the inner rod resembles the upper end of the human ulna; the same end of the outer rod resembles a swan's head; there are about 5600 inner rods, 4000 outer rods; *basilar cells* occupy the angle between the base of each rod and the basilar membrane.

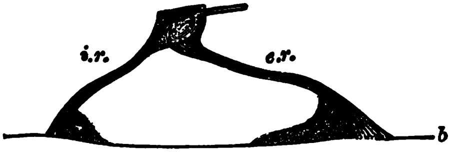


FIG. 147.—A pair of rods of Corti, from the rabbit (highly magnified) (Leidy).

Hair-cells^{a} (Fig. 148) are epithelial cells with stiff hair-like cilia β; *outer hair-cells*, external to the outer rods^{m}, present four rows, numbering about 12,000; *inner hair-cells* present a single row internal to the inner rods^{cd}, numbering about 3500. Each hair-cell, outer or inner, has about 20 hairlets. Beneath and between the hair-cells are the *cells of Dieters*, each expanding into a *phalangeal process ;* the

Lamina reticularis is formed of several rows of small fiddle-shaped cuticular structures called *phalanges*, connected together and to the heads of the outer rods, forming rings^{mno}, through which project the hairs of the outer hair-cells.

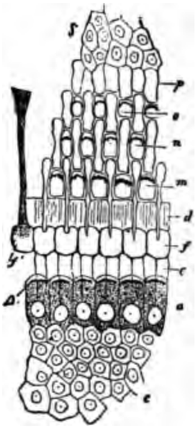


FIG. 148.—View of a small part of the human organ of Corti, from above (highly magnified).

Describe the auditory nerve.

Its *superficial origin* is by two roots, *mesial*, from the groove between the olivary and restiform bodies at the lower border of the pons (page 246) ; the other, *lateral*, winds around the restiform body apparently connected with the auditory striæ. It enters the internal auditory canal with the facial nerve, and at its end divides into an upper *vestibular portion* which comes from the mesial root only, and a *lower portion* which belongs wholly to the lateral root and passes through the foramina below the crista falciformis ; it gives off a *posterior branch* and the *cochlear nerve.*

It is here necessary to mention some of the bony parts involved. The end of the internal auditory canal is the *lamina cribrosa*, transmitting the nerves as seen in the diagram (Fig. 149). *Crista falciformis* runs across the *lamina*, separating a small superior fossa from a large inferior one. The upper fossa is the *area cribrosa superior ;* anterior to it is the orifice of the aquæductus Fallopii for the entrance of the facial nerve. The inferior fossa shows posteriorly (1) *area cribrosa media*, (2) *foramen singulare*, anteriorly (3)

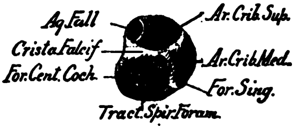


FIG. 149.—Fundus of the right internal auditory meatus (Quain).

tractus spiralis foraminulentus, ending in the *foramen centrale cochleæ* for the cochlear nerve.

The *vestibular division* of the auditory nerve splits into filaments which pass through the *area cribrosa superior*, and enter the vestibule through the macula cribrosa, to be distributed to the utricle and the ampullæ of the external and superior semicircular canals.

The *inferior division* by its *posterior branch* sends twigs through the *area cribrosa media* and the openings of the fovea hemispherica to supply the saccule; it sends another branch through the *foramen singulare* to the ampulla of the posterior semicircular canal; the

Cochlear nerve divides into numerous filaments at the base of the modiolus which enter its canals, pass between the two plates forming the lamina spiralis, forming a plexus which contains ganglion-cells, and sends branches to supply the inner and outer hair-cells; the

Intumescentia ganglioformis Scarpæ is on the vestibular branch in the internal auditory canal; the two *ganglia of Corti* are on the nerve to the posterior ampulla.

The *ganglion spirale* is on the cochlear nerve in the *canalis spiralis modioli*.

The branches of the auditory nerve and the apertures by which they leave the meatus are shown in the following table:

Superior division or vestibular nerve .		To utricle To superior ampulla To external ampulla	Area cribrosa superior.
Inferior division	Posterior branch	To saccule	Area cribrosa media.
		To posterior ampulla	Foramen singulare.
	Cochlear nerve		Tractus spiralis foraminulentus and foramen centrale cochleæ.

Give the arterial supply of the labyrinth.

The *internal auditory*, a transverse branch of the basilar, enters with the nerve the internal auditory canal, there to divide into a *vestibular* and a *cochlear branch;* the *stylo-mastoid*, from the posterior auricular; occasionally *branches from the occipital.*

THE ANATOMY OF INGUINAL HERNIA.

What is the inguinal canal?

The canal passing downward and inward for one and one-half inches (3.5 cm.), which lodges the spermatic cord in the male, the round ligament in the female, pursuing a course nearly parallel to Poupart's ligament through or between the abdominal muscles, commencing at the internal abdominal ring and terminating at the external abdominal ring[8] (Fig. 150).

Describe the internal abdominal ring.

It is an ovoidal opening in the transversalis fascia[13] midway between the anterior superior iliac spine and the symphysis pubis, about half an inch above Poupart's ligament[6]. It is bounded above and externally by arched fibers of the transversalis muscle[10], below and internally by the epigastric vessels[13]; from its circumference passes the *infundibuliform fascia* on to the spermatic cord or round ligament.

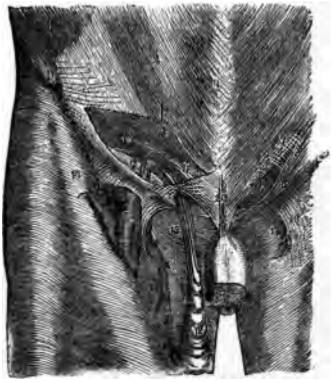


FIG. 150.—The anatomy of inguinal and femoral hernia (Leidy).

What is the external abdominal ring[8]?

An obliquely triangular opening in the aponeurosis[2] of the external oblique muscle[1], just above the crest and to the inner side of the spine of the pubes; from base to apex it averages one inch, by half an inch transversely. It is bounded below by the crest of the pubes, above and in front by the curved *intercolumnar fibers*[7] and on each side by the free borders of the aponeurosis called the *internal*[5] and *external columns*[6] or *pillars* of the ring; from the margins of the ring passes on to the cord or round ligament, the *intercolumnar fascia.*

Give the boundaries of the inguinal canal.

Anteriorly, the skin, superficial fascia, the aponeurosis of the external oblique throughout, and the outer third of the internal oblique muscles.

Posteriorly, the triangular fascia of the abdomen, conjoined tendon[11] of the internal oblique and transversalis muscles, transversalis fascia[13], subperitoneal tissue, and peritoneum.

Superiorly, the arched fibers of the internal oblique[10] and transversalis muscles.

Inferiorly, the union of the transversalis fascia[13] with Poupart's and Gimbernat's ligament[6].

What is Poupart's ligament[6]?

The infolded, thickened margin of the aponeurosis of the external oblique, extending from the anterior superior iliac spine[9] to the spine of the pubes, from which it is reflected a short distance along the pectineal line, forming *Gimbernat's ligament;* an oblique band of fascia or tendinous fibers arises from the external oblique aponeurosis of one side to be inserted into the pubic crest and the pectineal line of the opposite side, passing inward beneath the spermatic cord behind the inner pillar, in front of the conjoined tendon; it is called the *triangular fascia of the abdomen;* the lower part of Poupart's ligament forms the external pillar of the external abdominal ring[6].

Describe the relations of the epigastric artery and the internal abdominal ring.

It passes between the transversalis fascia and the peritoneum along the lower inner margin of the internal ring beneath the spermatic cord.

What is the cremasteric fascia?

A series of muscular loops connected by areolar tissue investing the spermatic cord, supposed to have been derived from the internal oblique muscle during the descent of the testicle, and, of course, absent in the female.

What is Hesselbach's triangle?

A triangular space at the lower part of the inner surface of the abdominal wall, bounded externally by the epigastric artery, and a fold of the peritoneum covering it, the *plica epigastrica;* internally by the margin of the rectus muscle, and below by Poupart's ligament; the conjoined tendon stretches across the inner two-thirds of this space.

What is an external or oblique inguinal hernia?

A protrusion of an abdominal viscus, usually of the bowel, omentum, or both, following the course of the spermatic cord in the inguinal canal through both the internal and external rings (*when complete*), the neck of the sac being to the *outer* side of the epigastric artery.

What are the coverings of an oblique inguinal hernia?

Skin; superficial fascia; intercolumnar fascia; cremasteric fascia; infundibuliform fascia, modified transversalis fascia; *subserous cellular tissue;* and *peritoneum* forming the *sac.*

Where is the seat of stricture most apt to be?

(1) At the internal ring, (2) the inguinal canal by fibers of the internal oblique or transversalis muscles, (3) at the external ring, provided it is not at the thickened neck of the sac, the most usual site in *old herniæ.*

What is an internal or direct inguinal hernia?

One where the protrusion passes through some part of Hesselbach's triangle, passing directly through the external abdominal ring, the neck of the sac being *internal* to the epigastric vessels.

What coverings has a direct hernia?

The same as an oblique, except that the *transversalis fascia* takes the place of the *infundibuliform fascia,* and the *conjoined tendon* is substituted for the cremasteric fascia; the fibers of the tendon may be forced apart or distended as an investment.

FEMORAL HERNIA.

Describe the femoral or crural canal (Fig. 150).

It lies beneath Poupart's ligament[6], to the inner side of the femoral vein[19], extending from the *femoral ring* above to the *saphenous opening*[17] below; it is about half an inch long, closed above by the *septum crurale*, formed of condensed areolar tissue, and below by the *cribriform fascia*, derived from the deep layer of the superficial fascia, or from the fascia lata, covering the saphenous opening.

The *femoral* or *crural ring* is an oval space between the femoral vein and Gimbernat's ligament, three-fifths to one inch in diameter, larger in the female than in the male, situated below and internal to the internal abdominal ring; it is closed by the septum crurale and a lymphatic gland; the

Saphenous opening[17], *fossa ovalis*, is an ovoidal opening one and a half inches long by half an inch wide, below the inner portion of Poupart's ligament[6], formed by the pubic portion[17] of the fascia lata passing behind the femoral vessels, while continuous with it by the *inferior cornu* is a strong *falciform process of Burns*[16], the iliac portion of the fascia lata, passing in *front* of the vessels, its narrow pubic portion blending with the attachment of Poupart's and Gimbernat's ligaments; this is called *Hey's ligament*[16] or the *superior cornu;* the opening is covered in by the *cribriform fascia.*

Bound the crural canal.

Anteriorly lie the transversalis fascia[13], Poupart's ligament[6], and the falciform process of the fascia lata[16];

Posteriorly, iliac fascia, covering the pubic portion of the fascia lata;

Externally, the fibrous septum separating it from the femoral vein;

Internally, the junction of the processes of the transversalis and iliac fasciæ forming the femoral sheath lying against the outer concave edge of Gimbernat's ligament.

Describe the position of parts around the ring.

The *spermatic cord* in the male, the *round ligament* in the female, lie just above the anterior margin; the

Femoral vein[19] lies upon its outer side; the

Epigastric artery crosses the upper outer angle of the ring; the

Obturator artery once in three and a half cases arises in common with the epigastric, when it may closely skirt around the upper and inner margins of the ring.

Describe the septum crurale.

It is a layer of condensed cellular tissue upon which lies a small lymphatic gland, closing the femoral ring.

What is the crural sheath?

It is a continuation downward of the fascia transversalis in front, and of the iliac fascia behind the femoral vessels forming their sheath, divided by two septa into three compartments for the femoral artery externally, the femoral vein next, and leaving a third internally, the femoral canal, or opportunity for it.

Describe the deep crural arch.

When present it is a band of fibers derived from the transversalis fascia, crossing the front of and adherent to the crural sheath, passing from the center of Poupart's ligament, the superficial crural arch, to the pectineal line behind the conjoined tendon.

Where is the seat of stricture most apt to be?

At (1) the junction of Hey's and Gimbernat's ligaments, (2) the margin of the saphenous opening, (3) the neck of the hernial sac.

What are the coverings of a femoral hernia?

They are *skin*, *superficial fascia*, *cribriform fascia*, *crural sheath*, *septum crurale*, *subserous areolar tissue*, and *peritoneum* forming the *sac*.

THE PERINEUM AND ISCHIO-RECTAL REGIONS.

Perineum (Fig. 151) includes the outlet of the pelvis from the apex of the subpubic arch to the tip of the coccyx, between the ischial tuberosities; breadth, three and a half inches (9 cm.); length, four inches (10 cm.). A transverse line just in front of the anus marks an anterior *urethral part*, *true perineum*, and a posterior *anal part*, the *ischio-rectal region*.

Ischio-rectal fossa^5, of a triangular shape, between the end of the rectum^x and the tuberosity of the ischium^c on each side; its base corresponds to the skin, and apex to the point of division of the obturator fascia and the origin of the anal fascia; its base is about one inch broad, its depth two inches, being deepest behind, and is bounded *internally*, by the sphincter ani[x], levator ani[5], and coccygeus[6] muscles; *externally*, by the tuberosity of the ischium[c] and obturator fascia; in *front*, by the line of junction of the superficial and deep perineal fasciæ; and *behind*, by the margin of the gluteus maximus muscle[11] and the great sacro-sciatic ligament.

Internal pudic vessels and *nerve* run about one and a half inches above the margin of the ischiatic tuberosity, in Alcock's canal.

Inferior hemorrhoidal vessels, occasionally large enough to give trouble after lithotomy, traverse the center of each fossa.

What is the perineum?

It is the anterior portion of the pelvic outlet, in front of the ischio-rectal region; it is of a triangular form, bounded, deeply, by the rami of the pubes and ischia, forming, superiorly, the pubic arch, and behind, by a line drawn between the ischiatic tuberosities; lateral boundaries measure three to three and a half inches. *The central point of the perineum* is one inch, membranous urethra one and a half inches, in front of the anus.

Describe the muscles of the perineum.

External sphincter ani[x]: *origin*, the tip of the coccyx[b] by a tendinous band and superficial fascia; *insertion*, the tendinous center of the perineum[2]; *action*, closes the anus; *nerve*, the fourth sacral and the inferior hemorrhoidal of the pudic.

Internal sphincter ani: consists of an aggregation of the involuntary circular fibers of the intestine, forming a muscular ring around the anal canal two lines thick and one inch broad.

Sphincter tertius (p. 276): a transverse fold extending into the rectum on the right side three inches above the anus.

Accelerator urinæ[1], *bulbo-cavernosus:* it has symmetrical halves with a median raphé; *origin*, central tendon of the perineum[2] and the median raphé in front; *insertion*, fibers spread over the front of the triangular ligament, encircle the bulb and corpus spongiosum, spread over the sides of the corpora cavernosa, to which they are partly attached and partly terminate in a tendinous expansion covering the dorsal vessels of the penis; *action*, empties the urethra after the bladder ceases to contract, perhaps aids in the erection of the penis; *nerve*, perineal branch of the pudic.

Erector penis[3], *ischio-cavernosus: origin*, inner surface of the tuberosity of the ischium, and the adjacent portion of its ramus (*erector clitoridis* in the female *arises* from the ischial tuberosity; *inserted* on the side of the crus clitoridis); *insertion*, by an aponeurosis covering the crus penis into the outer side and the under surface of that body; *action*, maintains erection; *nerve*, perineal of the pudic.

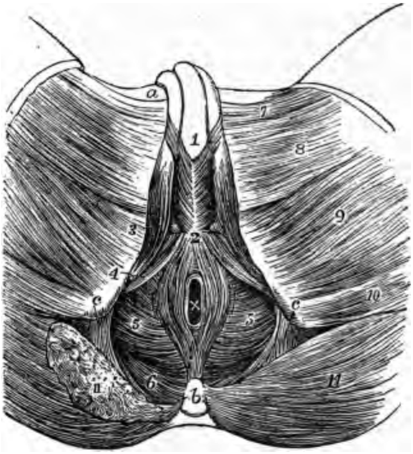


FIG. 151.—The muscles of the perineum (Leidy).

Transversus perinei[4]: *origin*, inner front side of the tuberosity of the ischium; *insertion*, tendinous center of the perineum meeting its fellow, external sphincter, and accelerator urinæ; *action*, steadies the perineal center; *nerve*, perineal of the pudic.

Levator ani[5]: *origin*, posterior surface of the body of the os pubis, spine of the ischium, from the "white line," which is the angle of division between the obturator and recto-vesical layers of the pelvic fascia; *insertion*, sides of the apex of the coccyx[b], opposite muscle by a median fibrous raphé, extending from the coccyx to the anal margin, the side of the rectum (or vagina) blending with the sphincter muscles, and the side of the prostate gland, uniting beneath it with the opposite muscle mingling with the external sphincter and transversus perinei muscles at the perineal center[2]; *action*, supports the rectum, vagina, and pelvic viscera, and with its fellow helps to form the floor of the pelvis, a muscle of forced expiration; *nerves*, perineal of the pudic and the fourth sacral.

Compressor or constrictor urethræ: *origin*, aponeurotic, from the ischio-pubic rami on each side, from layers of the triangular ligament; *insertion*, each muscle divides, surrounding the urethra from the prostate gland to the bulb of the urethra, uniting with the opposite muscle above and below this tube by a tendinous raphé; *action*, shut-off muscle; *nerves*, dorsal nerves of the penis from the pudic.

Coccygeus[6]: *origin*, from the spine of the ischium, lesser sacrosciatic ligament, or obturator fascia; *insertion*, into the margin of the coccyx and the side of the lowest segment of the sacrum; *action*, raises the coccyx; completes the pelvic floor; *nerve*, anterior branch of the fourth and fifth sacral.

Sphincter vaginæ surrounds the vaginal orifice, and is homologous with the accelerator urinæ in the male; *origin*, central tendon of the perineum; *insertion*, corpora cavernosa of the clitoris.

Erector clitoridis: it replaces the erector penis muscle.

Describe the perineal fasciæ.

The *superficial layer of the superficial fascia* is thick, loose, loaded with fat, and continuous with the fasciæ of the ischiorectal and crural regions; it has no bony attachments; the

Deep layer of the superficial fascia, *superficial perineal fascia*, *Colles' fascia*, are three names for an aponeurotic layer, continuous in front with the dartos of the scrotum, is firmly attached to the margins of the ischio-pubic rami, external to the crura of the penis as far back as the ischial tuberosities, and passes behind the transversus perinei muscles to become the anterior layer of the deep perineal fascia.

The *anterior layer of the deep perineal fascia* is attached above and laterally to the pubic arch, subpubic ligament and rami of the ischium and pubes beneath the crura of the penis, forming a dense membranous lamina, extending and attached to the tendinous perineal center becoming continuous with the deep layer of the superficial fascia behind the transverse perineal muscles; it embraces the anterior extremity of the membranous urethra, which passes through it one inch below the symphysis pubis, and is continued forward upon it.

The *posterior layer of the deep perineal fascia* is attached like the preceding, but more posteriorly, embraces the back of the membranous urethra, and is continued backward over the outer surface of the prostate gland, the two layers forming the *triangular ligament;* the portion of the urethra embraced between these layers is the *membranous urethra.*

The *pelvic fascia* shows a *white line* passing from the lower part of the symphysis pubis to the spine of the ischium; this marks the line of division into two layers, *obturator* and *recto-vesical fasciæ.* The former covers the lower part of the obturator internus, gives off *anal fascia* to the under surface of the levator ani; passing across the subpubic arch it forms the posterior layer of the triangular ligament.

The *recto-vesical fascia,* or *visceral layer of the pelvic fascia,* descends into the pelvis upon the upper surface of the levator ani muscle, investing the prostate, bladder, and rectum.

Describe Buck's or Colles' fascia.

It is a moderately dense fascia investing the penis as far as the glans, being a prolongation downward of the deep layer of the superficial abdominal fascia, forming the dartos of the scrotum; it directs the urine forward into the scrotum, penis, and upon the abdomen in rupture of the urethra.

What layers of fascia form the triangular ligament?

The superficial and deep layers of the *deep perineal fascia,* or the *anterior* and *posterior layers* of the *triangular ligament* (body horizontal), or the *inferior* and *superior triangular ligaments* (body erect); there are three names for each layer.

What structures lie between the layers?

Membranous urethra,
Compressor urethræ muscle,
Subpubic ligament,
Dorsal vessels of the penis,
Dorsal nerves of the penis,
Cowper's glands and ducts,
Internal pudic vessels,
Pudic nerves,
Arteries and nerves of bulb,
Venous plexus.

What structures are exposed by the removal of the deep layer of the superficial fascia?

The erector penis muscles covering the crura of the penis,

The accelerator urinæ muscle covering the corpus spongiosum and bulb,

Transversus perinei muscles,
Transverse perineal arteries.
Superficial perineal vessels.

What parts are divided in lateral lithotomy?

Skin,
Superficial and Colles' fascia,
Inferior hemorrhoidal vessels and nerves,
Posterior fibers of the accelerator urinæ muscle,
Transversus perinei muscle and vessels,
Superficial perineal vessels and nerves,
Triangular ligament, two layers,
Anterior fibers of the levator ani,
Part of the compressor urethræ,
Membranous and prostatic portions of the urethra,
Lateral lobe of the prostate gland.

What structures must be avoided in this operation?

In front, the bulb and its artery.

Externally, the internal pudic vessels and nerve.

Toward the median line and posteriorly, the rectum or neck of the bladder, the entire division of the lateral lobe of the prostate, venous plexus, or pelvic fascia.

Briefly describe the special points of interest connected with the female perineum.

The *perineal body* is the point of junction of all the muscular and aponeurotic structures of the perineum, forming a pyramidal mass of tissue extending for some distance up between the rectum and vagina, upon the integrity of which depends the proper support afforded to the pelvic viscera by the *floor of the pelvis.*

The length of the female perineum is only about one inch, extending from the posterior commissure to the verge of the anus; the *accelerator urinæ muscle* is replaced by the *sphincter vaginæ* encircling the vaginal outlet; the triangular ligament, formed essentially as in the male, and perforated by the urethra and vagina, is much smaller and weaker.

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